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Eugene P. Cooper  
Scientific Director

  
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Commanding Officer and Director

## PREFACE

This volume contains a numerical compilation of abstracts of Technical Reports (USNRDL-TR series) published by the U. S. Naval Radiological Defense Laboratory during the calendar year 1963. This volume supplements USNRDL-463, USNRDL-465, USNRDL-470, and USNRDL-477 as a continuation of the index of Technical Reports issued by the Laboratory; the index series includes information concerning all TR's published from 15 September 1953 to 31 December 1963. Each abstract is accompanied by its TR number, title, author(s), date of publication, and current classification. Classified material has been edited from the abstracts and titles of classified reports. The volume is UNCLASSIFIED. The Laboratory will continue to bring the index series up to date by the publication of current supplements.

For a listing of TR abstracts appearing in the Atomic Energy Commission journals entitled Nuclear Science Abstracts (NSA) (UNCLASSIFIED) and Abstracts of Classified Reports (ACR) (CLASSIFIED), see Subject Index entry "Reports (USNRDL-TR)."

In the Subject Index, entries list the report number, which may then be found in numerical order. Various divisional categories have been added in order to aid in the identification of material contained in the documents.

The Author Index lists all reports in which each author collaborated. The Division-Author Index indicates all documents issued by a specific division, together with their individual authors.

USNRDL-TR-568

COUNTERMEASURES FOR COPING WITH RADIOLOGICAL EFFECTS OF ACCIDENTS TO  
NAVAL REACTORS FOR SHORE POWER

M. G. Gibbons  
7 November 1963      80 p.      UNCLASSIFIED

At the request of the Bureau of Yards and Docks, a detailed recovery plan has been drawn up for coping with the early-time (emergency phase) radiological consequences of an accident to a shore-based naval nuclear reactor in which a significant portion of the core-contained fission products is released (major-release accident). The plan is presented in 76 steps involving automatic equipment actions and personnel actions. Special personnel requirements and special equipment to be used by personnel in carrying out their steps of the plan are specified in detail. Alarm-system requirements are also specified. A schematic diagram of the plan is given, including all of the steps. The plan is applicable also to offshore mounted (or floated, e.g., barge-mounted) reactors for shore power.

USNRDL-TR-600

EARLY-TIME GAMMA RADIATION FROM NUCLEAR WEAPONS (U)

J. M. Ferguson  
13 June 1961      28 p.      SECRET - RESTRICTED DATA

A semiquantitative study of the origin of early-time gamma radiation is made. Early time is defined as the first 10 seconds after a nuclear detonation. Four processes are considered: fission process gamma emission, fission product decay, neutron inelastic scattering, and radiative capture of neutrons in the air and soil. Gamma-ray spectra and spatial distribution are not considered; only total gamma-ray energy yields are estimated. The gamma-ray yields, in Mev per kiloton, are estimated for each of the above processes and for different types of nuclear devices. (Abstract UNCLASSIFIED)

USNRDL-TR-601

A SYSTEM FOR RAPID HANDLING OF AN IRRADIATED SOLUTION

A. E. Greendale and D. L. Love  
13 November 1962 15 p. UNCLASSIFIED

An apparatus has been constructed for rapidly transferring irradiated solutions to a container for fast radiochemical separations. A "rabbit" containing a solution is irradiated; within 1 second after irradiation it is transported through a pneumatic system to a receiver; there it impales itself onto two hypodermic needles connected to a container under vacuum. The irradiated solution and one acid wash of the rabbit are quantitatively transferred to the container within 2 seconds. Since the system is completely contained, there is no contamination of the laboratory area nor danger to personnel.

USNRDL-TR-602

A CONTINUOUS SCAN SCINTILLATION SYSTEM FOR THE INSPECTION OF TUNGSTEN BILLETS

H. A. Zagorites and K. F. Sinclair  
10 December 1962 27 p. UNCLASSIFIED

A continuous scan system, employing a 200-curie  $\text{Co}^{60}$  source, scintillation detection of transmitted radiation, differential direct current amplification and strip-chart recording, has been applied experimentally to the inspection of tungsten billets used in the fabrication of nozzles for solid propellant rocket motors. The results of a detailed inspection of an uninfiltated billet, supplied during the first phase of a round robin among a manufacturer and several Navy laboratories, were in agreement with radiographic data obtained during an earlier inspection. With this billet, the volume sensitivity of the system was measured to be about  $5.0 \times 10^{-2} \text{ cm}^3$ , which was within a factor of two of the predicted sensitivity of  $2.7 \times 10^{-2} \text{ cm}^3$ . The experimental work showed the feasibility of the continuous scan method as a primary inspection method for the inspection of tungsten billets and clearly demonstrated its usefulness in the present state of development as a supplement to film radiography.

USNRDL-TR-603

MATURATION OF LIVER FUNCTION IN THE CHICK EMBRYO

R. W. Brauer, L. M. Julian and J. S. Krebs  
14 December 1962 49 p. UNCLASSIFIED

A detailed study of the maturation of liver function in the developing chick embryo reveals at least three different time courses: BSP conjugation and concentrating or storing ability are well developed by the ninth day of incubation; maximal BSP transfer capacity matures by the fourteenth day; and clearance of BSP and ability to secrete selectively submaximal doses of BSP may not have reached maturity by the eighteenth day of incubation. While conjugating and concentrating abilities of the liver for BSP are clearly present on the eighth and ninth days, the ability to secrete BSP into bile does not appear until the eleventh day of incubation. Analysis of the data suggests two broad aspects of functional maturation: a. Functional maturation at the level of individual cells, including organelle development, membrane differentiation, and appearance of specific enzymes; b. Functional maturation at the organ level, involving both juxtaposition of cell populations and tissue elements, and uniformity of attainment of functional maturity.

USNRDL-TR-604

A METHOD OF COMPENSATING FOR TEMPERATURE-DEPENDENCE OF A REMOTE AREA GAMMA MONITORING SYSTEM

P. A. Covey  
27 November 1962 10 p. UNCLASSIFIED

A remote area gamma radiation monitoring system known as RAMS II was found to be so temperature-dependent that diurnal variations produced intolerably large output variations.

Addition of a thermistor-resistor combination in the cathode circuit of the electrometer tube successfully compensated for temperature effects. The response of the modified system is constant within  $\pm 10$  percent between 30 and 80°F, as opposed to an original factor-of-3 variation over this temperature range.



USNRDL-TR-605

MOUSE FETAL LIVER: A SOURCE OF IMMUNOLOGICALLY REACTIVE CELLS

M. L. Tyan and L. J. Cole  
3 January 1963 17 p. UNCLASSIFIED

Male and female AHeJ mice were mated and the resulting pregnancies were surgically interrupted at various stages of gestation. The embryos were dissected and identical organs (liver, thymus, gut, placenta, and umbilicus) from each separate pregnancy were pooled and injected i. p. into sublethally irradiated (500 rad) F<sub>1</sub> hybrids (either BALB/c x A)F<sub>1</sub> or (C57L x A)F<sub>1</sub>). Death of the F<sub>1</sub> hybrids within 60 days was the criterion for the presence of immunologically competent cells in the inoculum. At the end of this period the survivors were sacrificed, their spleens and lymph nodes homogenized, and injected i. p. into sublethally irradiated F<sub>1</sub> hybrids of the other type. Again death within 60 days was the criterion for the presence of immunologically competent cells in the inoculum.

One death occurred among the primary hosts (placenta 1/8). Immunologically competent cells (AHeJ) were detected in secondary recipients of second trimester fetal liver (3/3), second trimester thymus (3/3), and third trimester fetal liver (11/12). No immunologically competent cells (AHeJ) were found in secondary recipients of third trimester and newborn thymus (1/14). Deaths occurred among secondary hosts of fetal gut (3/5), umbilicus (1/3), and placenta (2/9). There were two deaths (2/29) among the secondary control mice. It is concluded that second and third trimester mouse fetal liver, second trimester fetal thymus, and perhaps other fetal tissues contain potential immunologically competent cells. The theoretical significance of these data is discussed.

USNRDL-TR-606

EFFECTS OF DIVIDED DOSES OF X RAY ON MORTALITY AND HEMATOLOGY OF SMALL AND LARGE DOMESTIC ANIMALS

G. F. Leong, W. G. Wisecup and J. W. Grisham  
7 January 1963 25 p. UNCLASSIFIED

An attempt to establish a correlation of systemic recovery with hematological recovery after X-radiation exposure for the mouse,

rabbit, sheep and goat, under uniform experimental conditions, is presented. This is part of a continuing program being conducted in this Laboratory in an effort to provide a valid estimate of the rate of recovery in man after radiation exposure by these correlative factors for various species.

By separating these animals into two broad groups, small and large animals, significant differences have been demonstrated as to their LD 50/30, hematological recovery, and systemic recovery. Furthermore, a significant departure from the generally accepted exponential recovery after a radiation insult has been shown for both small and large animals. The need for a more critical analysis of recovery at intervals well past the recovery half-time is indicated in evaluating rates of recovery.

USNRDL-TR-607

#### RAPID RADIOCHEMICAL PROCEDURE FOR ANTIMONY AND ARSENIC

A. E. Greendale and D. L. Love  
17 January 1962      19 p.      UNCLASSIFIED

A very rapid radiochemical procedure has been developed for antimony and arsenic. A sample is added to a 30 percent solution of  $H_2SO_4$  containing a carrier for antimony or arsenic (or both). This solution is dropped into a flask containing granular zinc at  $100^\circ C$ . The volatile stibine and/or arsine formed is passed through a hot quartz tube and decomposed to the metal, which collects as a metallic mirror on a cooler portion of the quartz tube. This metal is dissolved in  $H_2SO_4$  and assayed. The chemical yield is consistently between 70 and 80 percent. The time required for separation of the metal from the other elements of a fission product solution is about 10 seconds. The decontamination factors for the antimony procedure are: Mixed Fission Products (2 weeks old) =  $10^3$ , I =  $3 \times 10^4$ , Te =  $4 \times 10^4$ , Sn =  $> 10^5$ , As = 20-50. The decontamination factors for the arsenic procedure are: Mixed Fission Products =  $10^3$ , Sb =  $2 \times 10^3$ , Sn =  $> 10^6$ .

USNRDL-TR-608

SODIUM DEPENDENCE OF BIOELECTRIC OUTPUTS IN RAT STOMACH

J. T. Cummins and B. E. Vaughan  
14 January 1963 13 p. UNCLASSIFIED

When sodium in a Krebs-Ringer type media was replaced by choline, the potential difference across rat stomach as measured in vitro was substantially eliminated. Substitutions of sulfate for chloride and of sodium for potassium did not affect the bioelectric measurements. A residual potential of -2mV was detected, which was sensitive to anoxia and dependent neither on sodium nor on chloride.

USNRDL-TR-609

A DISPERSER FOR DEPOSITING SIMULATED DRY FALLOUT MATERIAL ON LARGE ROOF SURFACES

W. S. Kehrer  
13 December 1962 28 p. UNCLASSIFIED

A disperser was designed and constructed to disperse simulated dry fallout (graded sand) for roof washdown effectiveness tests continuously and uniformly over a 48 x 72 ft test area at a controllable dispersal rate of 0 to 4 g/min/ft<sup>2</sup>.

The major components of the system are: (1) the simulant handling equipment, (2) the individual dispersers, (3) the air system, and (4) the control panel.

The simulant handling equipment transports the simulant from an underground storage hopper to the individual dispersers. The specially designed items of this equipment are the eight adjustable splitters which divide the simulant falling through each into eleven equal volume streams which in turn feed the individual dispersers.

Each individual disperser consists of a sand blast nozzle located below a deflector plate. Fallout simulant and air are supplied continuously to the nozzle, which blasts it against the deflector plate; thereupon the simulant scatters and falls continuously over the test panels which are surfaced with different roofing materials.

The approximate amount of this dispersed simulant that lands on each panel is determined by the following method. The simulant transported from each test panel by the washdown water during the simultaneous fallout and washdown period is collected in a sieve and weighed. The residual remaining on the test surface after washdown ceases is collected in another sieve and weighed. The total of these two weights is the amount that lands on each panel. The simulant dispersal rate to each test panel and washdown effectiveness for each are then calculated from these weights.

USNRDL-TR-610

#### ON LATENT IMAGE FADING IN ILFORD K.O AND K.2 EMULSIONS

E. V. Benton  
4 January 1963      23 p.      UNCLASSIFIED

Fading in Ilford K.O and K.2 emulsions has been investigated at +20°C and -20°C. Track segments with rates of energy loss from 0.6 to 1.8 Mev/micron were used. K.O and K.2 emulsions stored for 30 days at -20°C showed no evidence of fading. After a 30-day fading period, K.2 emulsion stored at +20°C and at 50 percent relative humidity showed less than 10 percent fading. K.O emulsion stored at +20°C and at 50 percent relative humidity showed severe fading. This is illustrated by curves of grain density versus residual range for 2-, 6-, 13-, and 30-day fading periods.

USNRDL-TR-611

#### RADIOSENSITIVITY OF BIOELECTRIC FUNCTIONS OF RAT STOMACH AND CAECUM

B. E. Vaughan and A. K. Davis  
8 January 1963      32 p.      UNCLASSIFIED

Experimental studies of electrolyte absorption in the gastrointestinal tract have here established the existence of both delayed and immediate irradiation effects, as measured by bioelectric energy production in excised stomach and caecum tissues maintained in vitro. The delayed effects are dose dependent and show a neutron RBE of 2.7 compared to X rays. Both effects are produced indirectly, and the gastric reduction in bioelectric power requires irradiation change in

both the secretory epithelium and parasympathetic nerves. Hence, the differential radiosensitivity of stomach and caecum must be determined by indirect factors, undoubtedly biochemical, rather than by differences inherent in the composition of each tissue by itself.

USNRDL-TR-612 (DASA 1344)

#### HYDRA PROGRAM

#### DETERMINATION OF THE TOTAL THERMAL RADIANT ENERGY EMITTED BY AN UNDERWATER EXPLODING WIRE

J. S. Hege

10 January 1963

33 p.

UNCLASSIFIED

The total thermal radiation from an underwater spark has been determined by the measurement of the absolute radiation at two wavelengths as a function of time. Planck's law for thermal radiation was applied.

The spark was generated by electrically exploding a 5-mil. copper wire stretched between two submerged electrodes. The spark was assumed to be cylindrical with its length determined by the length of the wire.

The light measurements were made with two calibrated photoelectric tubes. Wavelengths of 407 and 610 millimicrons were selected with Farrand interference filters.

Values for the rates of total thermal radiation and values for the spark temperatures and radii were tabulated and graphed as functions of time for three explosions under three different sets of conditions. Total thermal radiation was obtained by graphically integrating the rate of thermal radiation over the time of the process. For two of the three explosions approximately 30 percent of the spark energy was emitted as thermal radiation. It was not possible to determine this fraction for the third explosion.

Analysis of the propagation of error shows that the error in the results for total thermal radiation is less than 7.5 times any error in the measurements of the radiation incident on the photoelectric tubes.

USNRDL-TR-613 (DASA 1346)

HYDRA PROGRAM

HYDRA IIA SERIES - A SYSTEM FOR THE MEASUREMENT OF LOW-ENERGY GAMMA RADIATION IN THE OCEAN

W. J. Gurney  
10 January 1963      36 p.      UNCLASSIFIED

Thirteen 10,000-pound, uncased, spherical charges of HBX-1 were fired underwater at Hydra IIA to determine, as a function of charge depth, the characteristics of the above-surface phenomena and the distribution of the resulting explosion products.

An underwater gamma radiation-measuring system was developed to determine the subsurface distribution of radioactively traced explosion products from several of the underwater detonations. The system consisted of two probes; one was fixed at a depth of 6 feet and the other was a variable-depth probe capable of providing continuous radiation and depth readings to 200 feet. These probes used 2-in. diameter, 2-in. high NaI (Tl) crystals, and were capable of measuring concentrations of low energy gamma-emitting radioisotopes as low as 1  $\mu\text{C}/\text{ml}$  in the sea immediately surrounding the shot point. Gamma energy sensitivity extended down to approximately 20 Kev. The complete measuring system was mounted aboard a naval landing craft (LCM).

USNRDL-TR-614 (DASA 1345)

HYDRA PROGRAM

HYDRA IIA SERIES - TIMING AND FIRING SYSTEM FOR 10,000-POUND UNDERWATER EXPLOSIONS

R. R. Soule  
10 January 1963      24 p.      UNCLASSIFIED

Thirteen 10,000-pound, uncased, spherical charges of HBX-1 were fired under water at Hydra IIA to determine, as a function of charge depth, the characteristics of the above-surface phenomena and the distribution of the explosion products.

This report describes the timing and firing system used to control instrumentation and to fire the charges, as well as the procedure for connecting the armed charges to the timing and firing system. The

system, using motor-driven punched-mylar tape which operated impulse relays, was capable of unattended operation after remote starting. Three misfires occurred; one was caused by chafing of the firing line, and two were caused by malfunction of a commercial component of the system. Detonation times of the thirteen shots are listed.

USNRDL-TR-615 (DASA-1340)

SPECTRAL DISTRIBUTION OF THE THERMAL RADIATION FROM THREE LOW YIELD NUCLEAR DETONATIONS

W. J. Parker  
31 December 1962      34 p.      UNCLASSIFIED

The relative spectral distribution of the total energy over the wave length range from 0.3 to 2.5 microns and of the irradiance at various times is reported for Bee, Moth, and Tesla, three low yield tower shots of Operation Teapot in 1955. These data were taken with a Medium Quartz Hilger spectrograph in which the photographic plate holder was replaced by an assembly of phototubes and lead sulfide photoconductive cells whose signal voltages were recorded on magnetic tape. The band widths varied from 0.05 to 0.35 microns and the time response was better than 100 microseconds. A method of obtaining more reliable spectral data on future weapons tests is also discussed.

USNRDL-TR-616

COMPARATIVE EFFECTS OF 50 KVP AND 250 KVP X RAYS ON THE DOG

S. J. Baum and E. L. Alpen  
24 January 1963      21 p.      UNCLASSIFIED

The subject of relative biological effectiveness of various ionizing radiations has been difficult and vexing to handle meaningfully when tissue distribution of dose is not uniform. It has been suggested by some that problems relating to linear energy transfer in tissues should appropriately be divided into two components - that relating to macroscopic energy distribution and that relating to energy distribution in terms of individual ionizing events. We have evaluated principally the former effect by looking at the biological potency of a lower energy X-ray source (50 kVp) in the dog.

Previously we have shown that no single dose parameter is adequate to express the biological potency of lower energy X rays, although it was suggested that, to the extent that it was possible to measure it, the dose to the critical organ, usually bone marrow, would be the most significant.

Further studies have been completed on dogs exposed to high doses of X radiation from a 50 kVp beryllium window generator. Doses of 4,000 to 10,000 rad (air) at the potential midline of the subject have been shown to be as effective as doses of 200 to 300 rad of 250 kVp X rays. Hematological comparisons of the two radiations show close correlation with mortality and a relative potency factor of  $\frac{1}{30}$  for the lower energy radiation. The lethal dose of 50 kVp X rays for the dog is 7,500 r (air). Serious lesions of the skin were seen as a complicating factor at all doses in excess of 4,000 r (air).

Dosimetry was done in tissue equivalent ("Mix D") wax phantoms using the rotational exposure method which is routine in this Laboratory. Phantom depth dose measurements with miniature ion chambers and chemical dosimetry in agar gels yielded essentially identical values of 3 percent for midline tissue dose.

USNRDL-TR-617 (DASA-1342)

#### XENON FLASHTUBES AS SOURCES OF THERMAL RADIATION

Kenneth A. Lincoln  
23 January 1963      44 p.      UNCLASSIFIED

Thermal radiative properties of xenon flashtubes have been studied by measuring radiant energies per flash and peak irradiances incident on small objects located at the center of selected helical flashtubes. Methods are described for determining these properties by employing black-body calorimeters in conjunction with oscilloscopic presentation of intensity versus time. Thermal pulses were found to be quite reproducible and are of the order of 1.0 to 1.7 cal/cm<sup>2</sup> per thousand joules of electrical input energy depending on the type of flashtube. Peak irradiances of over 7,000 cal·cm<sup>-2</sup>·sec<sup>-1</sup> were observed, and the influence of varying the capacitance and voltage was also determined.

In addition, some electrical characteristics of the flashtubes, such as current and resistance, were included in the measurements.



USNRDL-TR-618

ENVIRONMENTAL STUDIES OF A 100-MAN UNDERGROUND SHELTER

R. H. Heiskell

1 August 1963

77 p.

UNCLASSIFIED

Temperature studies were conducted during both simulated and human occupancy tests on the NRDL 100-man shelter. The temperature of the shelter remained comfortable during 14 days of human occupancy. The ventilating air movement through the shelter designed for 16 cfm per occupant was adequate to reduce the carbon monoxide concentration from heavy smoking to below safe tolerance limits and it removed 69 percent of the heat generated by the occupants with only 31 percent of the heat being dissipated through the walls. The shelter temperature varied between 74 and 90°F with an outside air temperature of 50 to 94°F during the simulated occupancy test and between 70 and 82°F during the human occupancy tests with an outside air temperature of 36 to 67°F. Poor distribution of the inlet air resulted in uncomfortably cool areas in the front of the shelter during the human occupancy test.

A preliminary analysis was conducted on a thermal analyzer to determine its potential as a tool for predicting shelter temperatures under various climatic conditions. This analysis showed only about 10 percent deviation from the measured temperature reported here.

USNRDL-TR-619

DIFFERENTIAL RADIOSENSITIVITY OF FIRST- AND SECOND-SET RESPONSES TO ALLOGENIC AND XENOGENIC SKIN GRAFTS IN LETHALLY IRRADIATED MICE

M. L. Tyan and L. J. Cole

5 February 1963

24 p.

UNCLASSIFIED

Two consecutive BALB/c mouse or rat skin tail grafts were placed on 12-14 week old female LAF<sub>1</sub> mice. One week following the rejection of the second graft, the mice received 870 rad whole body X radiation and an intravenous infusion of isogenic bone marrow. At various times following irradiation (0.2, 2.0, 13 and 30 days), groups of mice received orthotopic tail skin grafts from LAF<sub>1</sub>, BALB/c and C3D/2 mice, and Sprague-Dawley rats. The experiments were appropriately controlled. The resulting data demonstrated the differential

radiosensitivity of first- and second-set responses to either allogenic (H-2 difference) or xenogenic (rat) skin grafts: i.e., the second-set response of mice presensitized with either allogenic or xenogenic skin grafts is more radioresistant than is the first-set response; the second-set response to a xenogenic skin graft is more radioresistant than is that to an allogenic graft; the converse appears to be true with regard to the first-set response. The theoretical implications of these findings are discussed.

USNRDL-TR-620

#### GROSS DENTAL LESIONS IN THE RAT INDUCED BY X RAYS AND NEUTRONS

T. J. Castanera, D. C. Jones and D. J. Kimeldorf  
13 February 1963 27 p. UNCLASSIFIED

Male Sprague-Dawley rats were exposed at 101 days of age to wholebody doses of 430 or 680 rads of X rays or to 230, 320, or 360 rads of fast neutrons. Dental lesions, evidenced by chalky white zones in the tooth substance, began appearing at the gingival crest approximately 35 days postirradiation in the mandibular incisors and several weeks later in the maxillary incisors. The time of maximum incidence of animals with lesions occurred between the fiftieth and seventy-fifth days postirradiation and, by the end of the fourth month, all lesions had disappeared from the continually growing incisors through attrition at the occlusal edges. The total incidence of animals with one or more lesions was 97 percent after 430 rads of X ray and 100 percent after all other doses. The size of the lesions and the number of lesions per animal were greater at the higher doses for each type of radiation. In some animals fractures occurred at the lesion and were confined largely to mandibular incisors. The total incidence of animals with fractured incisors was greater at the higher doses for each type of radiation. Food in meal form, presented in open containers, resulted in a lower incidence of fractures as compared with the results of a previous study in which the same food in pellet form was supplied in wire mesh containers. Neutrons appeared to be two to three times more effective than X rays in producing the lesions.

USNRDL-TR-621

CALORIMETRIC MEASUREMENTS OF GAMMA RAY, FAST NEUTRON, AND CHARGED PARTICLE ABSORBED DOSES

E. R. Schleiger, N. Goldstein and E. Tochilin  
28 January 1963 31 p. UNCLASSIFIED

The energy absorbed by aluminum, carbon, or tissue-equivalent (TE) material when exposed to gamma rays, fast neutrons, or 900-Mev alpha particles was measured with a microcalorimeter. The instrument was patterned after the one described by Reid and Johns, Rad. Res. 14, 1 (1961), but has an ethylene glycol bath instead of water. Spaced mylar sheets about 6-1/2 in. in diameter were mounted on one side of the absorber inside the evacuated cylindrical chamber in order that the detector could be thermally insulated in the direction of the beam without the presence of bath solution.

Gamma-ray absorbed dose rates as low as 2 rads/min were measured with the instrument. The dose rates obtained from the exposures to  $\text{Co}^{60}$  and  $\text{Cs}^{137}$  sources at this Laboratory (NRDL) agreed with the output of the sources as measured with a National Bureau of Standards secondary standard cavity ionization chamber. Thirteen 10-min exposures of the TE absorber in the microcalorimeter to fast neutrons from the University of California 60-in. cyclotron at Crocker Laboratory resulted in absorbed dose measurements varying from 24 to 40 rads. The average absorbed dose value was 5 percent higher than the NRDL determination based on flux and spectrum measurements. Microcalorimeter exposures to the 900-Mev alpha particle beam from the University of California 184-in. synchro-cyclotron at Lawrence Radiation Laboratory gave absorbed doses that agreed reasonably well with ionization chamber determinations.

USNRDL-TR-622

MOTOR RESPONSES IN MOTHS TO LOW INTENSITY X-RAY EXPOSURE

J. C. Smith, D. J. Kimeldorf and E. L. Hunt  
25 February 1963 15 p. UNCLASSIFIED

A brief burst of X rays elicited flight activity in the moth when placed in a darkened X-ray exposure room. Wing-beat activity was recorded as an index of this behavior. Wing-beat activity could

be initiated in resting moths or amplitude augmented in active moths by X-ray dose rates of 0.01 - 1.5r/sec. with a latency of less than 1 second after onset of exposure.

USNRDL-TR-623

HYDRA PROGRAM  
THE NRDL LOW-YIELD UNDERWATER EXPLOSION TANK AND ASSOCIATED  
INSTRUMENTATION

R. R. Buntzen  
18 February 1963      25 p.      UNCLASSIFIED

A facility was designed and constructed to simulate underwater nuclear explosions on a very small scale by employing a submerged exploding wire in a contained environment. This facility is a laboratory complement to the NRDL HYDRA Program.

The variable pressure explosion tank and related mechanical features are described. Development of the energy storage system, trigger, and discharge circuit for the submerged exploding wire are discussed. The instrumentation needed to determine the explosion yield and the results for a 25-KV discharge are given.

USNRDL-TR-624

BEHAVIORAL AROUSAL AND NEURAL ACTIVATION AS RADIOSENSITIVE REACTIONS

E. L. Hunt and D. J. Kimeldorf  
27 February 1963      56 p.      UNCLASSIFIED

In a study designed to detect prompt reactions to ionizing radiation, rats were exposed to 250 kvp X rays and measurements of behavioral departures from sleep and of heart rate were used to indicate activation of the central nervous system. Exposure at a low dose rate (0.25 r/sec) produced a transitory arousal from sleep within the first 12 seconds (accrued dose of 3 r). At a higher dose rate (1.9 r/sec) this initial reaction increased in scope and, by 30 seconds, included also an acceleration in heart rate. Only animals exposed at the higher dose rate exhibited evidence of excitation during the residual period of exposure to a 1.000 r total dose. Accordingly, the

intensity of the reaction during exposure depended upon the dose rate rather than the total dose. A transient excitatory effect at the termination of exposure was indicated by the occurrence of behavioral wakefulness for a period of minutes following exposure at both dose rates. The excitatory effects of irradiation were not dependent upon adrenal function since adrenalectomized animals showed a sequence of reactions comparable to that shown by normal animals but with longer latencies. Stimulation through radiosensitive mechanisms apart from the visual receptor system was indicated since ophthalmectomized animals exhibited both behavioral and heart rate responses within seconds after the start of exposure. Some possible modes for the action of ionizing radiation as a stimulus to the nervous system are discussed.

USNRDL-TR-625

DIFFERENTIAL EFFECTS OF SPECIFIC ANTISERA ON THE REJECTION OF  
ALLOGENIC AND XENOGENIC SKIN GRAFTS BY SUBLETHALLY X-IRRADIATED MICE

M. L. Tyan and L. J. Cole

4 March 1963 19 p. UNCLASSIFIED

Twelve- to fourteen-week-old, female LAF<sub>1</sub> mice, nonsensitized or presensitized with two consecutive BALB/c or rat skin grafts, received 670 rad whole-body X radiation and orthotopic tail grafts of LAF<sub>1</sub>, BALB/c, C3D/2 and rat skin. Certain groups of mice received specific antisera intraperitoneally, produced in response to BALB/c or rat spleen cells or to two consecutive BALB/c or rat skin grafts. The data indicate that the first-set response to an allogenic skin graft can be significantly inhibited, in sublethally irradiated mice, by specific antisera, while the first-set response to a xenogenic skin graft remains resistant to similar treatment. Specific antisera had no effect upon a pre-existing second-set response. The significance of these data is discussed.

USNRDL-TR-626

AERIAL SURVEY OF THE SURFACE RADIOACTIVITY REMAINING AFTER AN  
UNDERWATER NUCLEAR DETONATION (U)

E. J. Wesley, R. Cole, Martha A. Olson and W. F. Joseph  
4 March 1963 103 p. SECRET

The surface pool of radioactivity remaining after an underwater nuclear detonation was delineated by radiation-detection instruments installed in a low flying aircraft. Isodose rate contours for each of seven consecutive days following the event were plotted and estimates of the decay of the peak dose rate and of a measure of total activity were obtained. Pulse height spectra of the activity from the pool as seen at the aircraft and of the background activity experienced in the aircraft were measured and analyzed. Some tests pertinent to airborne search for the surface pool resulting from a clandestine nuclear detonation were conducted. The whole project was reviewed with respect to its implication for the problem of policing the oceans of the world in the event of a nuclear test ban. (Abstract UNCLASSIFIED)

USNRDL-TR-627

THE RELATIVE EFFECT OF PULSED RADIATION EXPOSURE IN PRODUCTION OF  
ACUTE MORTALITY IN MICE

E. J. Ainsworth, G. F. Leong, E. L. Alpen and K. Kendall  
8 March 1963 17 p. UNCLASSIFIED

Mice have been subjected to pulsed exposures of either fission spectrum neutrons or gamma radiation produced by a Triga Mark F reactor. The acute mortality response of animals given pulsed radiation of the order of  $10^5$  rads/min has been compared with mortality responses obtained by neutron irradiation at 40 rads/min and gamma irradiation at 100 rads/min. No significant differences in LD<sub>50/30</sub> were observed as a function of dose rate with either gamma or neutron irradiation.

USNRDL-TR-628

DIFFERENTIAL RESPONSE TO ALLOGENIC AND XENOGENIC SKIN GRAFTS BY  
SUBLETHALLY IRRADIATED (670 rad) AND NON-IRRADIATED MICE  
SENSITIZED BY VARIOUS MEANS

M. L. Tyan and L. J. Cole  
11 March 1963 26 p. UNCLASSIFIED

Twelve- to 14-week old female LAF<sub>1</sub> mice were presensitized either with 3 i.p. injections of BALB/c or rat spleen or skin cells, or by means of two consecutive BALB/c or rat skin tail grafts. One week following the last injection or the rejection of the second skin graft, the mice either were grafted with LAF<sub>1</sub>, BALB/c, C3D/2 and rat skin or they received 670 rad whole-body X radiation and were grafted immediately thereafter. The data indicate that skin grafts induce a more vigorous and more radioresistant "second-set" response than do dissociated cells. Presensitization with allogenic spleen cells resulted in prolonged survival of subsequent allogenic skin grafts in sublethally irradiated mice. The second-set response to a xenogenic skin graft was found to be more radioresistant than was that to an allogenic graft. The converse was true with regard to the first-set response.

USNRDL-TR-629

CONSTRUCTION OF A MODIFIED HENDERSON APPARATUS

J. F. Pribnow and M. S. Silverman  
14 March 1963 13 p. UNCLASSIFIED

An apparatus for exposing mice to an aerosol of microorganisms has been developed. It is a modification of the Henderson apparatus, adapted for exposure of smaller animals. The design allows for placement of the complete apparatus in a bacteriological hood. Although of relatively simple design and operation, it has proven highly dependable.

USNRDL-TR-630

MUTUALLY TOLERANT HOST AND DONOR TYPE IMMUNOLOGICALLY COMPETENT CELLS  
IN MOUSE RADIATION CHIMERAS

W. E. Davis, Jr., M. L. Tyan and L. J. Cole  
19 March 1963 26 p. UNCLASSIFIED

Host type immunologically competent cells were found in 4 out of 15 LAF<sub>1</sub>(host)-C3H (donor) long-lived radiation mouse chimeras. Three of these 4 chimeras also had donor type lymphoid cells. Therefore, the host and donor immunocompetent cells must have co-existed in a state of mutual homograft tolerance. Of the remaining 11 chimeras tested, 6 did not exhibit host type immunocompetent cells, while 5 showed questionable host-derived immunological activity. Donor immunocompetent cells were detected in a total of 4 of the 15 LAF<sub>1</sub>-C3H chimeras. Host type (i.e., strain A) immunocompetent cells were detected also in two A-LAF<sub>1</sub> radiation chimeras. On the other hand, 10 C3H-C3D2F<sub>1</sub> radiation chimeras apparently did not contain host-derived immunogenic cells.

The presence of hematopoietic cells of host origin was detected in 4 out of 15 LAF<sub>1</sub>-C3H radiation chimeras. Host-derived hematopoietic cells were not detected in the A-LAF<sub>1</sub> radiation chimeras, and only 1 of the 10 C3H-C3D2F<sub>1</sub> radiation chimeras had host hematopoietic tissue. Therefore, within the limits of the test system employed, the hematopoietic cells in the remaining chimeras must be predominantly of donor origin.

USNRDL-TR-631

FRACTIONATION II.  
ON DEFINING THE SURFACE DENSITY OF CONTAMINATION

E. C. Freiling and S. C. Rainey  
13 March 1963 27 p. UNCLASSIFIED

This report presents a technical basis for defining surface density of fallout contamination when the contaminating debris is fractionated. Specifically, it recommends that the exposure dose rate from fractionated debris be expressed as a contamination surface density multiplied by the sum of three terms. The first term is the exposure dose rate contribution of refractorily behaving fission-product nuclides per unit contamination surface density. The second



term is a similar quantity for volatily behaving fission-product nuclides. The third term expresses the contribution of the induced activities.

USNRDL-TR-632

#### A RAPID RADIOCHEMICAL PROCEDURE FOR TIN

A. E. Greendale and D. L. Love  
28 February 1963 19 p. UNCLASSIFIED

A very rapid radiochemical procedure has been developed for the isolation of radioisotopes of tin from their fission-product isobars. An irradiated uranium solution containing tin and antimony carriers is added to a solution of sodium borohydride. The volatile stannane ( $\text{SnH}_4$ ) formed is decomposed in a hot quartz tube to the metal, which is collected on a cold surface. Stibine ( $\text{SbH}_3$ ), which is also formed under these conditions, is removed by absorption on an 'ASCARITE' column.

The tin chemical yield ranges between 15 percent for an Sb decontamination factor of  $2 \times 10^4$  to 60 percent for an Sb decontamination factor of  $10^5$ . The time required for separation of the tin metal from the other fission product elements is about 10 sec. Decontamination factors of other Sn descendents are: I =  $7 \times 10^4$ , and Te  $> 2 \times 10^4$ . Arsenic is also volatilized as the hydride; however, it is not necessary to eliminate it in this work for the determination of the Sn fission yield.

USNRDL-TR-633

#### ESTIMATED TOTAL CHAIN AND INDEPENDENT FISSION YIELDS FOR SEVERAL NEUTRON-INDUCED FISSION PROCESSES

L. E. Weaver, P. O. Strom and P. A. Killeen  
5 March 1963 46 p. UNCLASSIFIED

Calculated estimates are presented of unmeasured total chain yields and of independent fission yields for the fission products resulting from fission-spectrum and 14-Mev neutron bombardment of  $\text{U}^{233}$ ,  $\text{U}^{235}$ ,  $\text{U}^{238}$  and  $\text{Pu}^{239}$  and from thermal neutron bombardment of  $\text{U}^{233}$ ,  $\text{U}^{235}$  and  $\text{Pu}^{239}$ .

USNRDL-TR-634

THE EFFECT OF AGE AT EXPOSURE UPON THE RADIATION INDUCED DENTAL DEFECT  
IN RATS

D. C. Jones, T. J. Castanera and D. J. Kimeldorf  
21 March 1963 21 p. UNCLASSIFIED

Exposure of the rat to ionizing radiation results in formation of defective tooth substance which subsequently becomes visible at the gingival crest in the shaft of the continuously growing incisor. The present study is concerned with the effect of age at irradiation upon the severity and temporal distribution of the radiation-induced dental lesion. Male rats were irradiated with a high sublethal dose (215 rads) of fast neutrons at 31, 110, or 619 days of age. The typical lesion (a chalky zone extending the full width of the tooth) was observed in the exposed shafts of the incisors beginning in the second month post-irradiation. While all animals exhibited the lesion in all incisors, the character of the lesion and its time sequence varied markedly with age at irradiation. The severity of the radiation effect was greater in the youngest group, as indicated by a wider lesion and a greater incidence of animals with fractured incisors (68 percent vs 11 or 12 per cent for the older groups). The time sequence of appearance, duration of visibility, and disappearance by attrition at the occlusal edge occurred earlier in younger animals. However, these temporal differences appear related primarily to anatomic and physiologic factors associated with age per se rather than to a differential intensity of radiation damage.

USNRDL-TR-635

THERMAL EFFICIENCY OF A LAND-SURFACE NUCLEAR DETONATION (U)

C. P. Butler  
16 April 1963 23 p. CONFIDENTIAL RESTRICTED DATA

Measurements of the total thermal radiation from a small surface detonation in Frenchman Flat at the Nevada Test Site have been made at different distances. From these measurements, the thermal efficiency has been calculated. (Abstract UNCLASSIFIED)

USNRDL-TR-636

DIFFERENTIAL RADIOSENSITIVITY OF FIRST- AND SECOND-SET RESPONSES TO  
ALLOGENEIC AND XENOGENEIC SKIN GRAFTS IN SUBLETHALLY IRRADIATED MICE

M. L. Tyan and L. J. Cole  
15 April 1963 17 p. UNCLASSIFIED

Data are presented demonstrating the differential radiosensitivity of the first- and second-set responses of sublethally irradiated (670 rad) mice previously sensitized with allogeneic (H-2 difference), xenogeneic (rat), or both allogeneic and xenogeneic skin grafts. The second-set response is more radioresistant than is the first-set response; the second-set response to a xenogeneic graft remains intact during and following recovery from the effects of sublethal irradiation; while intact for a brief period following irradiation, the second-set response to an allogeneic skin graft was abrogated by sublethal irradiation (670 rad); concurrent presensitization with allogeneic and xenogeneic skin grafts prevented the abrogation of the second-set response to the allogeneic graft by sublethal irradiation; the first-set response to an allogeneic graft recovered from the effects of sublethal irradiation prior to the recovery of the first-set response to a xenogeneic graft.

USNRDL-TR-637

A METHOD FOR THE COLLECTION, STORAGE, AND MONITORING ANALYSIS OF  
NATURAL SEA WATER

H. Goya, P. Zigman, M. Lai and J. Mackin  
27 February 1963 33 p. UNCLASSIFIED

Natural seawater was required for use in experiments designed to determine the dissolution rate of certain nuclear fuel materials. A literature survey was conducted and a method was devised for the collection, storage, and analysis of the water. In brief, the method stipulates: (1) off-shore collection of surface water in polyethylene carboys which are subsequently stored, at a reduced temperature, in a dark location and (2) monitoring biological and chemical composition via microfiltration, chlorinity, oxygen, alkalinity, phosphate and nitrate analyses.

USNRDL-TR-638

USE OF  $\text{La}^{140}$  AS RADIOTRACER IN (PRE-BUGGY) CHEMICAL EXPLOSIONS  
Preparation and Determination of Its Reaction with Environmental  
Materials

W. B. Lane, M. J. Nuckolls and R. M. Railey  
4 April 1963 30 p. UNCLASSIFIED

The pre-Buggy experiment conducted by the U. S. Army Engineer Nuclear Cratering Group was designed to measure the fraction of vented radioactivity from a series of HE underground detonations containing radioactive sources.

NRDL assisted in this experiment by preparing 29 capsules containing curie amounts of  $\text{La}^{140}$  for shipment to the Nevada Test Site (NTS) on schedule. The level of gamma activity in each capsule was sufficient to provide a radiotracing of the debris which resulted from the detonation.

In addition, NRDL furnished "always open" fallout collectors to sample the debris, and a low-geometry scintillation counter to measure its  $\text{La}^{140}$  content.

Particle size measurements of the debris indicated that  $\text{La}^{140}$  was adsorbed on the surface of the soil particles. Some 96 percent of the activity was associated with subsieve particles representing only 8 percent of the mass and 90 percent of the available surface area.

USNRDL-TR-639

SOME RELATIONSHIPS AMONG PARTICLE SIZE, MASS LEVEL AND RADIATION  
INTENSITY OF FALLOUT FROM A LAND SURFACE NUCLEAR DETONATION

D. E. Clark, Jr. and W. C. Cobbin  
21 March 1963 79 p. UNCLASSIFIED

The simulation of a realistic fallout environment was required for the design of experiments to evaluate post-nuclear attack reclamation equipment and procedures. A simplified mathematical fallout model was utilized to estimate fallout particle sizes, accumulated initial mass levels, and standard radiation intensities that might occur under specified conditions of weapon yield and downwind distance from a land

surface nuclear detonation. Fallout particle size, deposited mass per unit area, and standard radiation intensity, as functions of downwind distance and weapon yields from 1 KT to 100 MT are presented graphically to facilitate rapid selection of simulated fallout environments.

USNRDL-TR-640

INHIBITION OF THYMIDINE KINASE - DNA POLYMERASE ACTIVITY IN THE KIDNEY  
BY X-RADIATION BEFORE OR AFTER UNINEPHRECTOMY

R. K. Main, L. J. Cole and E. R. Walwick  
23 April 1963 21 p. UNCLASSIFIED

Groups of rats were exposed to whole-body X-radiation (850 rad) at various time intervals either before or after unilateral (left) nephrectomy, and the remaining (right) kidney was removed 48 hours postnephrectomy. The specific activity of the kidney enzymes (thymidine kinase-DNA polymerase system) catalyzing DNA-synthesis was then assayed by measuring the incorporation of  $H^3$ -thymidine into DNA in vitro. The ratio of enzyme activity in right versus left kidney in each animal is termed the "induction ratio." The induction ratio was profoundly suppressed in rats irradiated at 10 minutes to 18 hours after uninephrectomy (values  $<1$ ); when irradiated between 19 and 24 hours after unilateral nephrectomy there was a sharp and precipitous rise in the induction ratios (values up to 6.6).

When radiation exposure was carried out between 15 minutes and 22 hours before uninephrectomy, the induction ratios were depressed ( $<1$ , and as low as 0.05). The evidence suggests that partial recovery from this latent radiation damage can occur if the time interval between irradiation and uninephrectomy is sufficiently prolonged; when this interval was 20 days, induction ratios attained values of 4.4.

The data indicate: (1) that the early steps in induction or formation of the thymidine kinase-DNA polymerase enzyme system are highly radiosensitive; (2) that latent radiation-induced damage to the enzyme-forming system occurs, i.e., when the radiation is applied before unilateral nephrectomy; (3) that this enzyme system in the kidney may be continuously renewed, with a turnover time of less than 48 hours.

USNRDL-TR-641

INHIBITION OF URETHAN LUNG TUMOR INDUCTION IN MICE BY TOTAL-BODY  
X IRRADIATION

W. A. Foley and L. J. Cole  
24 April 1963 24 p. UNCLASSIFIED

Groups of young adult (C57L x A)<sub>F</sub><sub>1</sub> mice received a single intra-peritoneal injection of urethan prior to or after a single whole-body lethal dose of X rays (880 rad) followed by transfusion of normal syngeneic bone marrow to protect against radiation death. This dose of urethan produced multiple tumors in 100 percent of nonirradiated animals at 24 weeks postinjection. In the irradiated animals there was marked suppression of lung tumor formation, both in number of animals with tumors, and in numbers of tumors per tumor-bearing animal. This suppression was present whether urethan treatment preceded or followed radiation. The results imply that urethan lung carcinogenesis may be interfered with by a direct inhibitory effect of the radiation on cells already altered by urethan, or through latent radiation inhibition of pulmonary alveolar proliferative capacity.

USNRDL-TR-642

ESTIMATES OF FISSION PRODUCT YIELDS OF A THERMONUCLEAR EXPLOSION

G. R. Crocker  
4 April 1963 26 p. UNCLASSIFIED

Chain yields and independent yields of the  $U^{238}$  fission products from a thermonuclear explosion have been estimated. Since unclassified data for this kind of process are scanty, some features of the mass yield curve were inferred from published data on  $U^{238}$  fission by neutrons ranging from fission-spectrum energies to 14 Mev. Independent yields of the fission products were then calculated by application of the equal charge displacement (ECD) theory of nuclear charge distribution in fission processes.

USNRDL-TR-643

PROPOSED NAVAL SHIP STANDOFF RANGES FROM NUCLEAR UNDERWATER BURSTS (U)

D. P. Schultze and C. J. Cillay  
7 May 1963 110 p. SECRET RESTRICTED DATA

A ship that launches a nuclear ASW weapon or participates in joint surface/air employment of a nuclear ASW weapon must be at a certain standoff range from the resulting underwater burst to avoid significant damage from underwater shock and excessive personnel doses from exposures to ionizing radiation. The shock hazard is determined by weapon yield, burst depth, ocean depth, and ship distance from surface zero (SZ); the radiation hazard, by the above four factors and also by wind-speed, the ship's position relative to SZ and the wind direction, and the ship's speed and heading after it launches the weapon. Shock standoff ranges were scaled from ship damage curves provided by the David Taylor Model Basin. Radiation standoff ranges were computed with an NRDL mathematical model recently formulated from base-surge data taken at five nuclear underwater bursts (Crossroads Baker, Wigwam, Wahoo, Umbrella, and Sword Fish). A recommended revision of the instruction on naval ship standoff ranges (OPNAVINST 003400.6) is presented in an appendix. Technical justification for the revised instruction is given in the text. (Abstract UNCLASSIFIED)

USNRDL-TR-644

REDUCED INCIDENCE OF PERSISTENT CHROMOSOME ABERRATIONS IN MICE  
IRRADIATED AT LOW DOSE-RATE

P. C. Nowell and L. J. Cole  
6 May 1963 18 p. UNCLASSIFIED

A marked difference in the production of persistent chromosome aberrations in mouse marrow cells by ionizing radiation delivered at a high dose rate (30 rad/min) versus a low dose rate (1.45 rad/hour) was observed. Clones of cell with chromosome abnormalities were present in the marrow of all the mice previously exposed to the X rays, either a single dose or fractionated, at 30 rad/min. The frequency of chromosome aberrations in these mice varied from 14 to 72 percent of the cells examined. By contrast, none of the 17 mice exposed to the continuous low dose rate gamma radiation (1.45 rad/hour) showed definite clones of abnormal marrow cells, and the frequency of persistent chromosome

aberrations varied from 0 to 8 percent in this group. The possible basis for this marked reduction in the production of persistent chromosome changes in marrow cells following exposure to low dose-rate gamma radiation is briefly discussed. If some of the late effects of radiation, particularly leukemia incidence, are related to the frequency of chromosome aberrations, it is possible that low dose-rate gamma radiation may be less leukemogenic than high dose-rate radiation.

USNRDL-TR-645

#### GROUND ROUGHNESS EFFECTS FOR FALLOUT-CONTAMINATED TERRAIN: COMPARISON OF MEASUREMENTS AND CALCULATIONS

J. M. Ferguson  
7 May 1963      29 p.      UNCLASSIFIED

The effect of ground roughness on the radiation field above fallout-contaminated ground is studied. At past weapons tests, the dose rate over fallout-contaminated ground has been measured as a function of height and angle. These measurements are compared with calculations of the same quantities for 1.12-hr fission products uniformly distributed on a smooth plane. None of the experiments is detailed enough to lead to firm conclusions about the ground roughness effect. However, the data indicate that the ground roughness effect can be simulated by assuming that the fallout is buried under a thin layer of material. For desert terrain this thickness of material is equivalent to about  $25 \pm 10$  ft of air. At 3 ft above the ground this corresponds to a reduction in dose rate by a factor of 0.6 to 0.7, compared to what would be received over a smooth plane.

USNRDL-TR-646

#### LIFESPAN MEASUREMENTS IN THE MALE RAT

D. C. Jones and D. J. Kimeldorf  
9 May 1963      30 p.      UNCLASSIFIED

Measures of lifespan were determined for a population of male Sprague-Dawley derived male rats, comprised of 747 animals from eighteen experiments. Variations in lifespan measures among experiments were found even under stable environmental conditions in a single



strain of rats with no known epidemic infections. Measures of central tendency and dispersion appeared to be uncorrelated with each other, and normally distributed among experiments. Within most experiments there was a definite tendency for an excess (above the normal distribution) of shorter lifespans, and in seven experiments this resulted in significant deviations from the normal distribution. On a composite basis, the frequency distribution of lifespans and the associated survival curve were not those of a normally distributed variate. Consideration of life expectancies at various ages and age specific death rates revealed that the "force of mortality" declines at advanced ages. These findings indicate the need for caution in selecting statistical procedures for analysis of lifespan information.

USNRDL-TR-647

THE DESIGN AND PERFORMANCE OF A FALLOUT-TESTED MANNED SHELTER STATION  
AND ITS SUITABILITY AS A SINGLE-FAMILY SHELTER

J. D. Sartor, P. D. LaRiviere, H. Lee and J. I. Pond  
23 April 1963 61 p. UNCLASSIFIED

The design details, cost analysis and performance characteristics are presented for small, partially-underground fallout shelters utilized as manned stations during a nuclear weapon effects test. Four men occupied each shelter and operated radiation measurement and fallout collection instruments.

Two types of shelters were designed to withstand predicted overpressures: Type I for a 1-psi overpressure and Type II for a 5-psi overpressure. The basic structure consisted of an 8-ft diameter, 10-ft long, 12-gage corrugated steel, multi-plate pipe. A steel entranceway incorporating two right-angle turns provided access to the basic structure. Depending upon the amount of soil backfill, fallout gamma radiation protection factors up to 470,000 were obtained.

The overall performance of the shelters under the conditions experienced was excellent. It is suggested that shelters of this type have application not only for use as manned stations in nuclear weapon testing but can be adapted as well for use in residential areas as single-family fallout shelters.

USNRDL-TR-648

RADIOCHEMICAL SEPARATION OF CARRIER-FREE SILVER, CADMIUM, AND RHODIUM  
FROM EACH OTHER BY SOLVENT EXTRACTION

L. Wish and S. C. Foti  
28 April 1963 16 p. UNCLASSIFIED

In some carrier-free radiochemical procedures for the analysis of fission products, the rhodium, silver, and cadmium radionuclides are separated by ion exchange. They are adsorbed preferentially on an anion column from weak hydrochloric acid solution. Most of the rhodium-105 is eluted first, but since there is tailing, some rhodium will be found with the silver and cadmium fractions. In order to reduce this contamination, two reagents, triisooctyl thiophosphate and triisooctylamine, were tested as liquid extractants for the three elements. Partition coefficients were obtained and from these a method was developed for the individual separation of silver and of cadmium from rhodium.

USNRDL-TR-649

CONVERSION OF THE AN/PDR-T1B RADIAC TO A REMOTE AREA MONITOR

P. A. Covey  
24 April 1963 14 p. UNCLASSIFIED

A reliable remote-area monitor was devised from two AN/PDR-T1B gamma survey meters by coupling the electronics of one unit, located at the readout position, with the ion chamber from a second instrument located at the remote monitoring position. Cable lengths up to 50 ft were used with no appreciable signal degradation. The instrument is useful in fields up to 500 r/hr, and it has produced measurements agreeing with a standard NRDL Model 103 gamma intensity versus time recorder (GITR) to within  $\pm$  20 percent.

USNRDL-TR-650

THE DISPOSITION OF NA, MN, AND AL AT TWO CALIFORNIA BEACHES

F. M. Tomnovec and J. M. Ferguson  
9 May 1963 24 p. UNCLASSIFIED

The disposition of Na, Mn, and Al in California beaches was examined by studying two typical beaches, one near San Diego at Camp Pendleton, and one at Ocean Beach in San Francisco. A profile of the amount of Na, Mn, and Al contained in each beach soil is presented from the water's edge to several hundred feet inland. An attempt was made to follow the growth and leaching of Na from the Ocean Beach area over a period of several months during the winter (rainy season). During the 1963 rainy season the experiment was abruptly terminated when the passage of a series of large storms removed the beach area where the experiment had taken place.

USNRDL-TR-651

CILIATED EPITHELIAL CELLS IN NORMAL MURINE INTRAHEPATIC BILE DUCTS

J. W. Grisham  
17 May 1963 16 p. UNCLASSIFIED

Rare cilia have been noted on cells of normal murine intrahepatic biliary epithelium. In general structure these cilia resemble typical kinocilia, but the precise internal structure of the ciliary process has not been ascertained. The function or implication of the presence of cilia on these cells is not absolutely known; they may represent embryological remnants without function.

USNRDL-TR-652 (DASA 1376)

THERMAL RADIATION AND FIRE EFFECTS OF NUCLEAR DETONATIONS

S. Martin and A. Broido  
10 May 1963 48 p. UNCLASSIFIED

An unclassified state-of-the-art review of the thermal effects of nuclear weapons, this report summarizes the pertinent information available at the end of 1962. Evidence is presented to show that, in a nuclear weapon attack on targets in urban and rural areas, thermal radiation and fire can be expected to make a major contribution to the destruction of life and property. The characteristics of the emitted thermal radiation, the radiant exposure as a function of distance, and the effects produced by this radiation are summarized. The formation, spread, and control of fires and possibilities for survival in fire zones are discussed. Fire countermeasures which might prove effective in reducing the extent of thermal damage are set forth.

USNRDL-TR-653

A MODEL FOR COMPUTING BASE-SURGE DOSE-RATE HISTORIES FOR UNDERWATER NUCLEAR BURSTS (U)

I. O. Huebsch

27 May 1963

106 p.

CONFIDENTIAL FORMERLY RESTRICTED DATA

A model for calculating transit-radiation dose rates and doses from the base surge of an underwater nuclear burst is described. Calculated values are compared with measurements made at Hardtack Wahoo and Umbrella, Crossroads Baker, and Wigwam, and with predicted values for two proposed underwater shots. The model is a geometrical-radiological representation of the base surge, whose characteristics depend on weapon yield, burst depth, and surface wind speed. The model is estimated to be valid for 1-KT to 100-KT underwater bursts for minimum burst depths of 20 to 90 ft, respectively, and for times at least 30 seconds after burst. Dose rates and doses can be computed for either fixed or moving points in the radiation field. The comparisons show that the calculated values, in almost all cases, agree within  $\pm 50$  percent of the measured values. (Abstract UNCLASSIFIED)

USNRDL-TR-654

SUPPLEMENTARY ESTIMATES OF RADIATION GEOMETRY AND ENERGY RESPONSE FOR USNRDL GAMMA-INTENSITY-TIME RECORDER (GITR) MODEL 103

H. R. Kinnert

13 May 1963

41 p.

UNCLASSIFIED

Estimates of radiation response are presented for the Model 103 Gamma-Intensity-Time Recorder (GITR) as used at Operation Sunbeam. The GITR detector unit, consisting of two concentric ionization chambers, was mounted inside the GITR recorder case and located 3 ft above ground level. GITR responses and their time-dependence were estimated for several idealized radiation source geometries and several calculated gamma energy spectra. Estimated response values are presented as fractions of the GITR's calibration-response to  $\text{Cs}^{137}$  radiation beamed at the top of the unmounted detector along its longitudinal axis.

The principal conclusions drawn were that:

(1) The GITR responses to distributed sources with specified gamma energy spectra did not show a significant dependence upon the source geometries investigated.

(2) There were about 17 percent differences between the responses of the two concentric detectors.

(3) The responses changed about 15 percent during the first 100 hours after fission.

(4) The use of overall average GITR responses for distributed sources seems warranted; there is 95 percent confidence that 95 percent of the population of GITR responses will be within 12 percent of the overall average response of 1.16 for the high-range detector, and within 14 percent of the overall average response of 0.99 for the low-range detector, during the first 110 hours after fission.

Because these response values are measures of the bias in the GITR calibration technique, the bias can be corrected (or at least minimized) by dividing the recorded GITR data by the above-mentioned overall average GITR response values.

USNRDL-TR-655

#### PRIMER ACTIVITY OF THYMUS DNA FRACTIONATED BY ECTEOLA COLUMN CHROMATOGRAPHY

W. D. Skidmore, R. K. Main and L. J. Cole  
12 June 1963 25 p. UNCLASSIFIED

The DNA-primer activity of Ecteola fractionated calf- and rat-thymus DNA samples was determined by a DNA-polymerase assay system.

All DNA samples assayed, heated or unheated, and fractionated or unfractionated, showed some degree of DNA-primer activity.

The chromatographic profiles of heated DNA were different from those of unheated DNA. Phenol and p-aminosalicylate, used in the preparation of DNA, did not alter the patterns of DNA obtained by Ecteola chromatography. Sephadex chromatography was found to be a rapid and effective method to deionize DNA solutions.

DNA-primer activity was increased by an ammonium hydroxide gradient. At 4°, treatment of DNA by phenol and p-aminosalicylate, Ecteola column chromatography with a salt gradient, Sephadex column chromatography with deionized distilled water to desalt DNA, and lyophilization did not alter DNA-primer activity.

The results indicate that DNA-primer activity, per se, is not specifically associated with one particular fraction of DNA.

USNRDL-TR-656

#### RECOVERY OF PETROLEUM REFINERIES CONTAMINATED BY FALLOUT

L. Minvielle and W. Van Horn  
24 June 1963 156 p. UNCLASSIFIED

The Office of Civil Defense, Department of Defense, is sponsoring a series of studies on the recovery of certain essential major industries in the U.S. from the effects of nuclear attack. Various agencies are developing recovery input data that will eventually be fed to automatic computers to prepare production programs, consistent with surviving resources, for meeting priority requirements during the first two years after attack.

The present study deals with the petroleum refinery industry. The case studied is that in which a given refinery is contaminated by radioactive fallout from one or more nuclear detonations occurring essentially simultaneously at some distance so that the refinery is not damaged by blast or fire. Before recovery of the plant can be started, entry into the plant area must be postponed until the radioactivity has decayed sufficiently so that excessive radiological doses will not be accumulated by recovery personnel. After entry, personnel must first decontaminate the vital areas of the plant, and then repair the equipment that has been damaged because of insufficient shutdown time. Estimates of the times and efforts required for recovery are made for

a subgroup of 16 refineries that encompass all refinery sizes found in the industry; standard intensity\* ranges of radioactive fallout from 300 to 30,000 r/hr are considered. Generalized empirical formulations of these estimates are developed for the subgroup and are applicable to all refineries in the industry. Estimates of the times for recovery can be calculated for various choices of the controlling parameters--length of work shift; standard intensity; size of refinery; etc.

Recommendations are made that would reduce the effects of such attacks on oil refineries and expedite their recovery.

USNRDL-TR-657

#### PRIMARY AND SECONDARY GRAIN DENSITIES OF HEAVY IONS IN INSENSITIVE EMULSIONS

E. V. Benton and H. H. Heckman  
6 July 1963 26 p. UNCLASSIFIED

The grain densities of stopping  $C^{12}$ ,  $O^{16}$ , and  $Ne^{20}$  ions have been measured as a function of velocity ( $\beta \leq 0.145$ ) in insensitive Ilford emulsion types K minus 1 and K-O. The measurements were carried out using photomicrographic techniques. An exponential gap-length distribution is observed for gap lengths greater than 0.25 microns for rates of energy loss up to 2.35 MeV/micron. The composition of the grain density is analyzed in terms of primary and secondary grain densities. It is concluded that the secondary grain density, which is due principally to  $\delta$ -rays, accounts for about 35 percent of the total grain density observed in these insensitive emulsions. A generalized formula derived from these data expresses the observed grain density as a function of the particle's velocity and charge, and the sensitivity of the emulsion.

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\* The standard intensity of a radiation field is the value of the intensity in r/hr when extrapolated back to 1 hour after burst. The use of the standard intensity simplified the representation of the results and the calculations based on them.

USNRDL-TR-658

COMPILATION AND EMPIRICAL ANALYSIS OF THERMAL EXPOSURE DATA FROM  
NUCLEAR SURFACE BURSTS (U)

R. W. Shnider

12 July 1963

43 p.

SECRET RESTRICTED DATA

A tabulation is presented of all available radiant-exposure data from nuclear surface bursts. The data are separated into surface exposures and airborne (measured in aircraft) exposures, and pertinent information, such as instrumentation and cloud cover, are included when available. The empirical analysis presents one set of Radiant Exposure vs Range curves for surface exposures, and another set for airborne exposures. Both sets are normalized to 1 KT, and distinguish between Nevada Test Site atmosphere (excellent thermal transmission) and Pacific Proving Ground atmosphere (average-to-low thermal transmission). It is recommended that these curves be employed for prediction of radiant exposures from nuclear surface detonations, rather than other methods in current literature. (Abstract UNCLASSIFIED)

USNRDL-TR-659

CIVIL DEFENSE UTILIZATION OF SHIPS AND BOATS

W. H. Van Horn and D. Freund

16 July 1963

244 p.

UNCLASSIFIED

Various ways in which ships and boats might supplement the overall civil defense program were investigated. Both merchant and reserve ("mothball") fleet ships were considered for the part they might play in a lifesaving, life-sustaining civil defense capacity. Data for two port cities were analyzed to obtain information on population distribution and shipping activity. Engineering feasibility studies were made of the use of ships as personnel shelters and the availability of ships' utilities for use by shore installations. The protection offered from nuclear fallout radiation was calculated for two classes of ships. It was concluded that ships and boats could provide evacuation or fallout-shelter facilities, or both, before or during a nuclear attack. For the postattack situation, ships could serve as headquarters, hospitals, living quarters, storehouses, and prime producers of electrical power and potable water. It is recommended that further studies be made of selected port cities to



determine how ships and boats could best be used to supplement present civil defense capabilities of these cities.

USNRDL-TR-660

#### IGNITION OF CELLULOSIC KINDLING FUELS BY VERY BRIEF RADIANT PULSES

S. Martin  
15 July 1963      30 p.      UNCLASSIFIED

Radiant exposure values are reported for sustained flaming ignition of black  $\alpha$ -cellulose, newspaper and kraft corrugated board exposed to constant-irradiance, thermal inputs of 30 ms duration and longer. The radiant exposure values are shown to be approximately proportional to the thickness of the exposed material and not strongly dependent on exposure duration for pulses this brief. The significance of sustained flaming ignition, relative to ablation effects, for pulses of very brief duration is discussed.

USNRDL-TR-661

#### ADULT THYMUS: LIMITED ROLE IN RECOVERY OF HOMOGRAFT RESPONSE IN IRRADIATED MICE

M. L. Tyan, L. J. Cole and W. E. Davis  
24 July 1963      10 p.      UNCLASSIFIED

Thymectomized and sham-thymectomized adult LAF<sub>1</sub> and CBA mice received lethal irradiation and were protected with syngeneic bone marrow. Thirty days after irradiation the survivors were grafted with allogeneic and xenogeneic (rat) skin. The thymectomized mice rejected their rat grafts only slightly later than did the mice in the sham-thymectomy group; in contrast, allogeneic grafts survived significantly longer on the thymectomized mice than they did on the mice in the control group.

USNRDL-TR-662

SOIL-MOISTURE PREDICTION METHOD FOR NRDL INDUCED-ACTIVITY PREDICTION  
SYSTEM

E. Laumets  
17 July 1963      61 p.      UNCLASSIFIED

Part of the military problem of predicting the gamma-radiation doses at 3 feet above the ground produced by the radioactivity induced in soil elements by neutrons emitted from nuclear air bursts is that of predicting the moisture content in the top soil layer of interest. The greater the moisture content in this layer, the closer to the surface lies the major part of the thermal neutron flux, since hydrogen atoms in the water are highly effective in thermalizing neutrons. Thus, there is less attenuation of the resulting gamma radiation by the soil. A method of predicting the soil moisture content in the top 6 inches of soil is described. The method, whose computational procedure follows a simplified "bookkeeping" form, is based on soil textures and experimental values on daily moisture accretion and depletion for different seasons of the year. The method is applicable to both free and impeded drainage conditions. The method is demonstrated by simple and complex examples.

USNRDL-TR-663

TOTAL HEMISPHERICAL EMITTANCE MEASUREMENTS OVER THE TEMPERATURE  
RANGE 77°K TO 300°K

R. J. Jenkins, C. P. Butler and W. J. Parker  
6 August 1963      63 p.      UNCLASSIFIED

Total hemispherical emittance measurements were made on a series of high emittance black paints, metal blacks, and anodized aluminum over the temperature range from 77 to 300°K by measuring the rate of temperature decay of a coated disk in a vacuum. Analytical and experimental analysis show that errors inherent in the method are less than 1 percent of the emittance of a black body at the temperature of the measurement, although instrumental errors and uncertainties in the heat capacities of the specimens reduce the accuracy of the reported data to  $\pm 10$  percent. The blackest material measured was electrically deposited platinum black on gold. The emittance of a black paint appeared to be more dependent on the thickness than it could be applied

than on the specific type of paint. Heavily anodized aluminum exhibited an emittance near 77°K of about 0.6, nearly as high as the best black paints, although it looked bright to the eye. The best platinum black coating had an emittance above 0.9 at 77°K. The metal blacks and the black paints had emittances above 0.95 at room temperature.

USNRDL-TR-664

THE RGI-20 RADIAC SYSTEM -  
A WIDE RANGE BETA-GAMMA INSTRUMENT

II. THE SOLID STATE PULSED GM TUBE LOW RANGE ACCESSORY PROBE

W. F. Joseph  
2 August 1963      30 p.      UNCLASSIFIED

A plug-on low range accessory consisting of a main unit and a cable-connected probe has been developed for the RGI-20 radiac system. The solid state circuit for pulsed GM tube operation is contained in the main unit whose dimensions are approximately 2 x 2-1/2 x 6 in. The GM tube is mounted in a cable-connected probe with side and end beta window provisions.

Ranges covered by the unit are 0-1, 0-10, 0-100, and 0-1000 milli-rad/hr; temperature affects accuracy by less than ±20 percent from -40 to +50°C.

The operating power, rate-computing circuit, and scale-changing meter display are provided by the basic high range (0-1000 rad/hr) RGI-20 module.

USNRDL-TR-665

NUMERICAL INTEGRATION OF A FUNCTION HAVING POLES NEAR THE LIMITS OF  
INTEGRATION

N. E. Scofield  
2 August 1963      16 p.      UNCLASSIFIED

An algorithm for numerical quadrature of functions having singularities near but outside of the integration limits is developed and

an example of its use is presented. The method is based upon a rational fraction interpolation function whose parameters are found by the use of reciprocal differences and a continued fraction representation. A comparison made with the same input data shows this method much better than a Simpson and somewhat better than a Newton-Cotes integration.

USNRDL-TR-666

THE PROTECTIVE EFFECT OF DEEP BODY HYPOTHERMIA ON X-RAY INDUCED  
MITOTIC ABERRATIONS OF REGENERATING RAT LIVER

M. J. Ashwood-Smith and G. F. Leong  
7 August 1963 22 p. UNCLASSIFIED

The protective effect of hypothermia against X-ray induced mitotic aberrations of regenerating rat liver has been studied. The mitotic index of control and irradiated animals was but little affected by the hypothermic treatment, whereas the effect of X rays on retarding growth (body weight) was reduced considerably by hypothermia. Furthermore, the number of X-ray induced mitotic aberrations in regenerating rat liver of hypothermic irradiated rats was reduced to the control values. It was concluded that this latter effect was probable due to the extreme anoxic state rather than the concomitant hypothermia.

USNRDL-TR-667

RESIDUAL RADIOACTIVITY FOLLOWING CYCLOTRON SHUT-DOWN

C. Sharp Cook  
20 August 1963 40 p. UNCLASSIFIED

This report reviews the physical interactions through which residual radioactivity can be developed in the shielding vault of the NRDL 70-inch AVF cyclotron and discusses in general terms the design characteristics that affect the magnitude of the ultimate residual radiation field that will be found. By comparison with measurements at other cyclotrons, estimates of the expected maximum residual gamma-radiation fields are reported. From the results it appears that, under certain conditions of operation of the NRDL cyclotron, residual radiation fields after shut-down may possibly present a serious hazard,

but it should be possible, through careful design of specific parts of the cyclotron, to keep the magnitude of this radiation below hazardous levels.

USNRDL-TR-668

#### INDUCTION OF HOMOGRAFT TOLERANCE IN SUBLETHALLY X-IRRADIATED ADULT MICE

W. E. Davis and L. J. Cole

19 August 1963 15 p. UNCLASSIFIED

It is now established that long-lived radiation chimeras, produced after the exposure of mice to lethal whole-body X-radiation and infusion of allogeneic bone marrow cells, are specifically tolerant to donor type skin homografts. However, these tolerant mice represent the minority of animals thus treated which survive the secondary disease syndrome. Our objective, therefore, has been to attempt to achieve homograft tolerance in sublethally irradiated adult mice under conditions which avoid secondary disease. Allogeneic mice which share the same H-2 locus, but differ at other histocompatibility loci, have now been used with some success. A tolerant state has been produced in CBA (H-2<sup>K</sup>) mice by first exposing them to sublethal X-radiation (500 rad) or urethan treatment coupled with irradiation, and then injecting C3H (H-2<sup>K</sup>) spleen ( $18 \times 10^6$ ) and/or bone marrow ( $42 \times 10^6$ ) cells within 3 days post irradiation. These mice have retained subsequent C3H skin homografts (over 165 days) but have rejected BALB/c skin grafts (H-2<sup>d</sup>) within 33 days. On the other hand, irradiated and urethan-treated controls, uninjected or injected with X-ray inactivated (2000 rad *in vitro*) C3H cells, rejected both C3H and BALB/c homografts by 70 days. Similar results, although less definitive, have been obtained using C3H (H-2<sup>K</sup>) or BALB/c (H-2<sup>d</sup>) as the recipient mice and CBA (H-2<sup>K</sup>) or DBA/2 (H-2<sup>d</sup>) mice, respectively, for the donor cells. Such procedures, however, have been unsuccessful in producing homograft tolerance between donor and host F<sub>1</sub> hybrid mice which have one H-2 histocompatibility locus in common but differ at the other, for example, CAF<sub>1</sub> (H-2<sup>d</sup> + <sup>a</sup>) and LAF<sub>1</sub> (H-2<sup>b</sup> + <sup>a</sup>). The significance of these results with regard to the requirement of cellular chimerism for the induction and maintenance of homograft tolerance is discussed.

USNRDL-TR-669

RADIONUCLIDE RELEASE FROM AERO-SPACE NUCLEAR REACTOR FUELS  
I. SAFETY ANALYSIS OF PULSED NEUTRON IRRADIATION OF DRY FUEL

J. L. Mackin and P. E. Zigman  
8 August 1963 28 p. UNCLASSIFIED

The safety of in-core exposures of ROVER/NERVA fuel to pulsed neutron irradiation has been analyzed. Exposure in a dry environment of fuel specimens containing 1 gram of  $U^{235}$  to a TRIGA Mark F power transient (following a three dollar step increase in reactivity) was examined. These examinations indicate that expected temperatures, pressures, and radiation levels are well within required safety limits.

USNRDL-TR-670

AROUSAL REACTIONS WITH A BRIEF PARTIAL- AND WHOLE-BODY X-RAY EXPOSURE

E. L. Hunt and D. J. Kimeldorf  
23 September 1963 18 p. UNCLASSIFIED

A study was made to determine the sensitivity of the mammalian nervous system to nonvisual stimulation with ionizing radiation. Blinded rats were exposed, while asleep, to a 1-second burst of X rays, and measurements of behavioral arousal and heart rate were made to indicate activation of the central nervous system. The stimulus was immediately effective since reaction latencies of 1 second or less were frequently recorded. The relative incidence of arousal and of a heart rate reaction was found to be related to the radiation dose rate over the range of 0.05 to 3.2 r/sec. The threshold dose rate was less than 0.05 r/sec. To test for regional distribution of sensitivity, additional blinded animals were exposed to a burst of X rays at the dose rate of 1.0 r/sec. with exposure limited to the head region or to the rest of the body. In that arousal was elicited with exposure of either region, it is evident that sensitivity to X-ray stimulation is widely distributed. Since exposure of the head produced a greater incidence and duration of disturbance, differential sensitivity between regions corresponds more closely to the density of ganglionic tissue than to the total tissue volume exposed. The results of the study are consistent with the postulation that ganglionic tissue is directly sensitive to ionizing radiation.

USNRDL-TR-671

GAMMA RADIATION EFFECTS ON ISOPRENOIDS

I. SQUALENE

J. F. Pestaner and R. Y. Yahiku  
9 August 1963 27 p. UNCLASSIFIED

Squalene, a liquid hexamer having the fundamental isoprenoid molecular structure of natural rubber, was irradiated with cobalt-60 gamma rays. The squalene was radiolyzed in vacuum and the dose absorption varied from 0.13 to 2.1 megarad. Gas chromatographic product analysis showed that hydrogen and methane are produced in the greatest amounts. The values obtained were in units of G (molecules per 100 ev of energy absorbed) where  $G(H_2) = 0.58 \pm .02$  and  $G(CH_4) = 0.018 \pm .001$ . The yields of ten other low molecular weight products were measured with a total  $G < .003$ .

A relationship of hydrogen yield from the radiolysis of squalene and other simple isoprenoid structures to that of rubber was demonstrated.

USNRDL-TR-672

DESIGN CRITERIA FOR ROOF WASHDOWN SYSTEM

Phase 1. Fallout Removal Studies on Typical Roofing Surfaces for Two Size Ranges of Particles (177-350  $\mu$  and 350-590  $\mu$ )

R. H. Heiskell, W. S. Kehrre, N. J. Vella and G. Brown, LCDR,USN(Ret)  
18 July 1963 75 p. UNCLASSIFIED

Fallout simulant particles ranging in size from 177 to 350, and 350 to 590 microns were deposited on selected typical roof sections 48 ft long by 8 ft wide to determine the effect of water flow rate, slope, and surface type on washdown effectiveness. More than 90 percent of the simulant can be removed on composition shingles, aluminum shingles, and roll roofing at slopes of 1:12 or steeper with 2 to 3 gallons of water per minute per foot of roof width (gpm/ft). It was found that washdown is ineffective on tar and gravel roofing without prior removal of the loose gravel. Washdown on a fiberglass epoxy laminated roof will remove better than 99 percent of the simulant particles with a water flow rate as low as 1 gal/min/ft.

USNRDL-TR-673

THE EFFECT OF AGE AT IRRADIATION UPON LIFESPAN IN THE MALE RAT

D. C. Jones and D. J. Kimeldorf  
10 September 1963 27 p. UNCLASSIFIED

Male rats (average number/group = 127) were exposed to a single whole-body high sublethal (30-day) dose of fast neutrons ( $220 \pm 10$  rads) at one of five ages ranging from the juvenile to the late adult stages of life. Lifespan functions for these groups were compared with those of littermate controls. For nonirradiated control groups of this Sprague-Dawley strain the median lifespan was 703 days (S.D. = 41 days). In terms of the median or mean survival time, life expectancy, age-specific death rate, and survival curve, there was a marked detrimental effect of irradiation in animals exposed at 1 month of age. This radiation effect diminished progressively when exposure occurred at 3 or 10 months of age, and was no longer discernible in groups exposed at 15 or 21 months. For those age groups (1, 3, or 10 months) which exhibited a significant alteration in lifespan functions, there was a latent period of seven to ten months before the effect became apparent. It appears that age at exposure is an important stipulation for consideration of long-term effects of irradiation. Further, it appears that animals exposed to sublethal (acute) doses of radiation after complete maturity has been attained may show little or no alterations in lifespan functions.

USNRDL-TR-674

MODIFICATION OF AN/PDR-18A RADIACS FOR RADIATION-MONITORING TRAINING

E. J. Leahy, P. E. Huebner, ETCS, USN and F. J. Kirby  
21 August 1963 15 p. UNCLASSIFIED

A method of modifying the high-range military radiac, the AN/PDR-18A, for training purposes is described. The modified radiac indicates dose rates of 0 to 500 r/hr when exposed to actual dose rates of 0 to 500 mr/hr. The modified radiac retains all the operating features and the appearance of the standard AN/PDR-18A. The modification consists of substituting a Geiger-Mueller detector for the AN/PDR-18A scintillation detector and changing certain electronic components. The entire modification can be accomplished by electronic technicians in the field in about 4 man-hours at a cost of about \$30.00



for materials. Photographs and a modification drawing are included.

USNRDL-TR-675

CORRELATION FUNCTION CALCULATION OF HIGHER ORDER CORRECTIONS TO THE  
LATTICE THERMAL CONDUCTIVITY

W. C. Schieve and R. J. Hardy  
24 September 1963 83 p. UNCLASSIFIED

Making use of the correlation-function formulation, we have expressed the thermal conductivity in a power series in  $\lambda$ . The Hamiltonian is  $H = H^0 + \lambda V'$ , where  $H^0$  is the harmonic part. The lowest order contribution is proportional to  $\lambda^{-2}$ ; this has been previously shown to agree with results predicted by the Boltzmann-transport equation. Using the generalized master equations of van Hove and Janner to treat the time dependence, we have investigated the contributions to the thermal conductivity of order  $\lambda^{-1}$ . The contributions arise from: (a) the new nondiagonal elements in the lowest-order flux operator; (b) the effects of the perturbation on the flux operator; and (c) the higher-order terms in the perturbation treatment of the time dependence. We have found that these corrections may be calculated by means of Boltzmann-like equations.

USNRDL-TR-676

CRITICAL STUDIES ON THE DETERMINATION OF THE THYROID SECRETION RATE  
IN COLD-ADAPTED ANIMALS

O. Heroux and R. W. Brauer  
26 September 1963 36 p. UNCLASSIFIED

There is ample evidence in the literature showing that cold adaptation in mammals can be accompanied by increased as well as by decreased thyroid activity.

Measurement of thyroid secretion rate by determining the amount of L-thyroxine required to block the thyroïdal  $I^{131}$  release, according to Perry's method, revealed that the thyroxine requirement of  $6^{\circ}\text{C}$ -acclimated rats was twice as high as that of controls ( $5.5 \pm 0.7 \mu\text{g}/100\text{g/day}$  against  $2.73 \pm 0.3 \mu\text{g}/100\text{g/day}$  for the controls). The

requirement of the white rats acclimatized to cold outdoors during the winter, on the other hand, was less than in the controls (1.8  $\mu\text{g}/100\text{g}/\text{day}$ ).

The larger amount of thyroxine found in the feces of the  $6^{\circ}\text{C}$ -acclimated rats ( $5.75 \pm 0.3 \mu\text{g}/\text{day}$  as compared to  $2.84 \pm 0.4 \mu\text{g}/\text{day}$  for the controls), the similar rate of urinary elimination of  $\text{I}^{131}$  in both groups, and the greater fecal elimination of the same isotope in the " $6^{\circ}\text{C}$ -rats" indicates that the greater requirement for thyroxine in these animals is at least partly due to increased fecal loss of the hormone.

The suggestion is made that under natural outdoor environmental conditions, normal fecal elimination or even normal utilization of thyroid hormones might prevail during the winter.

USNRDL-TR-677

GEOMETRY AND BARRIER ATTENUATION GENERATED BY A VERTICAL SLAB EXPOSED TO A PLANE  $\text{Co}^{60}$  SOURCE

G. E. Plummer and W. G. Miller  
27 September 1963 50 p. UNCLASSIFIED

A solution to the problem of how one may determine the dose received by a detector that has a vertical barrier interposed between it and a horizontal infinite radiation field has been attempted. Steel barriers of effective mass thickness 0 to  $73 \text{ lb}/\text{ft}^2$  were employed. The detector was collimated so that regardless of its distance from the barrier it always saw a constant circular area on the barrier.

The infinite radiation field was simulated by a traveling  $\text{Co}^{60}$  source that was pumped through an array of plastic tubing that covered a 100-ft semicircular area. An extrapolation to the infinite field case was attempted. The final results are expressed as ratios of dose received by a collimated, shielded detector relative to the free-in-air dose received by an unprotected detector 3 ft above the plane. The experimental points are compared to a family of theoretical curves.

USNRDL-TR-679

HEAVY MASS YIELDS IN THE SLOW NEUTRON FISSION OF  $U^{233}$

L. R. Bunney and E. M. Scadden  
12 September 1963 21 p. UNCLASSIFIED

The chain yields of masses 157, 159 and 161 in the thermal neutron fission of  $U^{233}$  were determined by radiochemical methods. The last radioactive member of the mass chain was isolated and its activity measured relative to  $Mo^{99}$ . With this ratio and pertinent data from the thermal neutron fission of  $U^{235}$ , the mass chain yield was calculated. The chain yields are: mass-157 (15.4 hr -  $Eu^{157}$ )-.00635 percent, mass-159 (18.5 hr -  $Gd^{159}$ )-.000905 percent and mass-161 (6.9 d -  $Tb^{161}$ )-.000117 percent. These yields are higher than was to be expected from analogy with the relative yields from thermal neutron fission of  $U^{235}$  and  $U^{238}$ . A possible explanation is given.

The chain yields of masses 91, 141, 143, 144, 147, 149, 151 and 153 in the thermal neutron fission of  $U^{233}$  and  $U^{235}$  were also determined in the same manner as above. The values, when compared to the literature values for the chain yields, provided an estimate of the accuracy of the radiochemical measurement. The accuracy is estimated to be  $\pm 10$  percent.

A new value has been calculated for the chain yield of mass-157 in the thermal neutron fission of  $U^{235}$ . An improved value has been obtained for the chain yield of mass-156 in the thermal neutron fission of  $U^{233}$ .

USNRDL-TR-680

FRACTIONATION III.  
ESTIMATION OF DEGREE OF FRACTIONATION AND RADIONUCLIDE PARTITION FOR  
NUCLEAR DEBRIS

E. C. Freiling  
12 September 1963 46 p. UNCLASSIFIED

This report presents a simplified, semitheoretical model of fractionation, suitable for making interim estimates of degree of fractionation and of radionuclide partition between local, intermediate, and worldwide fallout. The principles set forth are applicable to the

treatment of air-, tower-, and surface-burst debris (in the order of decreasing confidence) and to correcting fallout-prediction systems for fractionation effects. The material provides the first step necessary to illustrate theoretically the definition of contamination level proposed in Part II of this series.

USNRDL-TR-681

THE EFFECT OF SOURCE DISTANCE ON BUILDUP FACTOR FOR GAMMA RAYS  
PENETRATING INTO A COMPARTMENTED STRUCTURE

S. Tomoeda, A. L. Frank and M. B. Hastings  
8 October 1963 44 p. UNCLASSIFIED

In order to correlate some basic measurements of radiation attenuation made on an aircraft carrier to other situations and geometries, experiments were carried out to study the effects of source distance on the dose distribution inside a model-sized compartmented structure intended to simulate the carrier.

Data are presented in the form of buildup factors ( $B_r$ ) as a function of source-to-detector distance for two configurations of the compartmented structure. Buildup factors are also presented as a function of the slant path through the interposing steel plates for the case where the source is considered far from the structure.

Comparisons of the buildup factors within our complex structure with the more basic single-slab dose-buildup factors obtained by other investigators are also presented.

In every case, the buildup factor for the compartmented structure was found to be consistently and significantly lower than the single-slab data. The greatest differences in buildup ( $B_r-1$ ) amounted to 30 percent.

Starting with the source irradiation point against the center of the structure front face and moving away along the perpendicular to the front face, the buildup factor at the detector position of the center compartment nearest the source increased smoothly while the buildup factors at the detector positions of the two further center compartments remained approximately constant. The buildup factors of all the detector positions in the noncenter compartments decreased smoothly. At a distance of about 20 in., or roughly twice the largest dimension of a compartment, the buildup factors for all detector positions had

become nearly constant so that doubling or tripling the source-to-detector separation distance produced practically no change in  $B_T$ .

Among the several effects that contribute to the buildup, the slant path of the primary radiation and the effects due to the geometry of the detector and slab appear most important.

USNRDL-TR-682

#### EEG DESYNCHRONIZATION BY X RAYS IN RATS WITH TRANSECTED SPINAL CORDS

G. P. Cooper and D. J. Kimeldorf  
14 October 1963 13 p. UNCLASSIFIED

Rats with transected spinal cords showed EEG desynchronization and behavioral arousal to whole-body or head-only X-irradiation at dose rates between 0.5 and 1.5 r/sec. No arousal or EEG desynchronization occurred when only the body of a spinal transected animal was exposed. Results indicate that neither the circulatory system nor the vagi are essential to the arousal reaction to X-irradiation.

USNRDL-TR-683

#### SPECIFIC SUPPRESSION OF WOUND HEALING IN MICE BY GRAFT-VS-HOST REACTION

L. J. Cole, P. C. Nowell, and W. E. Davis, Jr.  
14 October 1963 20 p. UNCLASSIFIED

Young adult (C57L x A) $F_1$  mice bearing full-thickness skin grafts from A/HeJ mice received a single dose of 500 rad X-radiation, followed by ip injection of  $6 \times 10^6$  lymph node cells from normal A/HeJ donors; controls were injected with inactivated A/HeJ lymph node cells (i.e., 2000 rads *in vitro*). Circular punch skin wounds through the donor skin graft and adjacent host skin were made 8 days later. The mice receiving the intact parental strain lymph node cells showed symptoms of transplantation disease, while the controls were free of such signs. Skin wound healing was assessed histologically in mice sacrificed 3 and 6 days after wounding, permitting a comparison of healing in the donor skin-versus-host skin on the same mouse. The findings indicate a definite specific inhibition of wound healing in LAF $_1$  skin as compared

to A-skin in the mice suffering from transplantation disease. In each of seven mice examined 6 days after injection of A-strain lymphoid cells, healing in the grafted A-strain skin was definitely greater than in the host's own (LAF<sub>1</sub>) skin. Thus, the LAF<sub>1</sub> skin at this time showed only minimal to early healing, while the wounds in the grafted A-skin were completely closed in four of seven cases, of which two were healed. The possible theoretical basis for the specific inhibition of wound healing in graft-versus-host disease is briefly discussed.

USNRDL-TR-684

#### DETERMINATION OF THE HALF-LIVES OF Pm<sup>143</sup> AND Pm<sup>144</sup>

L. R. Bunney and E. M. Scadden  
30 September 1963 19 p. UNCLASSIFIED

The half-life of Pm<sup>143</sup> has been determined as  $267 \pm 15$  d and of Pm<sup>144</sup> as  $349 \pm 16$  d. Promethium-143 was produced by an ( $\alpha$ ,2n) reaction on Pr<sup>141</sup>, and Pm<sup>144</sup> was produced by a (p,n) reaction on enriched Nd<sup>144</sup> (95.7 percent). Irradiation conditions were selected that would minimize the formation of other promethium isotopes. The decay of Pm<sup>143</sup> was followed on gamma-ray counters and that of Pm<sup>144</sup> on gamma-ray and beta-ray counters. The energies of the gamma-rays emitted during the decay of these isotopes were determined from gamma-ray pulse-height distribution curves and were in agreement with the published data.

USNRDL-TR-686

#### CALCULATIONS AND NOMOGRAMS FOR USE IN A NEUTRON-INDUCED ACTIVITY PREDICTION SYSTEM

P. A. Read  
29 October 1963 30 p. UNCLASSIFIED

A method is described for calculating the expected induced activity gamma dose rate, given a thermal neutron flux distribution varying only with depth in the ground. The results of a number of such calculations are discussed. A set of nomograms incorporating the results of the calculations is presented, and their construction is discussed. The nomograms themselves constitute a rapid and convenient calculating device for use in an induced activity dose rate prediction system.

USNRDL-TR-692

A HIGH-VACUUM GAS-INLET APPARATUS FOR GAS CHROMATOGRAPHY

J. F. Pestaner, W. E. Shelberg and R. Y. Yahiku  
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A reliable gas-inlet apparatus is described for introducing micro-molar gas samples quantitatively into a gas chromatograph.

## SUBJECT INDEX

### A

Ablation, 660  
 Adaptation (Physiology), 676  
 Aerosols, 629  
 Aging (Physiology), 634, 673  
 Air, 618  
 Aircraft, 626  
 Aircraft carriers, 681  
 Alpha particles, 621  
 Aluminum, 650  
 Animals  
     radiation injuries, 606  
 Antimony isotopes (radioactive)  
     separation, 607  
 Antisubmarine warfare, 643  
 Arsenic isotopes (radioactive)  
     separation, 607  
 Attenuation, 677, 681  
 Atmospheric motion, 639

### B

Beaches, 650  
 Biliary system, 651  
 Biosynthesis, 640  
 Blood  
     radiation effects, 606  
 Blood cells, 630  
 Boats, 659  
 Body weight, 666  
 Bone marrow, 616, 630, 644  
 Brain, 682

### C

Cadmium isotopes Cd-109, 648  
 California, 650  
 Calorimeters, 621  
 Cardiovascular system, 682  
 Cells (Biology), 651  
 Cellulose, 617, 660  
 Chromatographic analysis, 655,  
     671, 692  
 Chromosomes, 644  
 Cilia and ciliary motion, 651  
 Civilian defense, 659  
 Cobalt isotopes Co<sup>60</sup>, 677  
 Cold climate, 676  
 Countermeasures, 652, 656, 659  
 Cyclotrons, 667

### D

Density, 631  
 Deserts, 645  
 Desoxyribonucleic acids, 640,  
     655  
 Detonations, 652  
 Digestive system  
     effects of radiation, 611  
 Dosage, 616  
 Dose rate, 621, 624, 627, 631,  
     644, 645, 653, 662, 670,  
     677, 680, 681, 686



## E

Electric discharges, 623  
Electrolytes (physiology)  
    absorption, 611  
Embryos, 603  
Emissivity, 612, 663  
Enzymes, 640  
Epithelium, 651  
Exploding wire phenomena, 612, 623  
Exposure, 629, 652, 658, 660

## F

Fallout, 672  
Fast neutrons, 620, 621, 627, 673  
Fires, 652  
Firing mechanisms (ammunition),  
    614  
Fission, 633, 642, 679  
Fission product activity, 669  
    Nuclear weapons, 600  
Fission products, 633, 642  
Flames, 660  
Flash lamps, 617  
Fractionation, 631, 655, 680  
Functional analysis, 665

## G

Gamma counters  
    calibration, 604  
Gamma emission, 613, 684  
    nuclear weapons, 600  
Gamma radiation, 649, 662, 671,  
    686  
Gamma rays, 621, 627, 644, 681  
Ganglia, 670  
Gases, 692  
Growth, 666

## H

Half-life, 684  
Healing, 683  
Hemopoietic system, 616  
Hypothermia, 666

## I

Identification systems, 626  
Ignition, 660  
Immune serums, 625, 636  
Immunity, 619, 628, 630, 661  
Immunization, 605  
Induced radioactivity, 667,  
    686  
Instrumentation, 692  
Integration, 665  
Intensity, 639  
Ionization chambers, 649, 677  
Ions, 657  
Isoprenoids, 671  
Isotope separation, 632

## K

Kidneys, 640

## L

Lanthanum isotopes  $\text{La}^{140}$ , 638  
Lattice theory, 675  
Life span, 646, 673  
Liver, 603, 605, 666  
Lungs, 641

## M

Mammals, 605, 670, 676  
 Manganese, 650  
 Mathematical prediction, 677, 680, 686  
 Metal coatings, 663  
 Mice, 625, 629, 661, 683  
 Micro-organisms, 629  
 Military personnel, 674  
 Mitosis - Measurement, 666  
 Models (simulation), 639, 653, 681  
 Moths, 622

## N

Naval vessels, 643  
 Neoplasms, 641  
 Nerves, 682  
 Nervous system, 624, 670  
 Neutron capture gamma rays, 600  
 Neutron activation, 633  
 Nomographs, 686  
 Nuclear effects, 660  
 Nuclear explosions, 635, 643, 653, 656, 658, 686  
 Nuclear reactions, 667  
 Nuclear reactors hazards, 568  
 Nuclear warfare, 659  
 Nuclear weapons, 652  
     radioactivation analysis, 600  
     tests, 615

## O

Oceans, 626

## P

Paints, 663  
 Paper, 660  
 Particles, 672, 680  
 Particle size, 639, 680  
 Particle tracks, 610, 657  
 Perturbation theory, 675  
 Photographic emulsions, 610, 657  
 Platinum black, 663  
 Plutonium, 633  
 Probes (Electromagnetic), 613, 664  
 Promethium isotopes, 684  
 Pyrolysis, 617

## R

Radiation chemistry, 632  
 Radiation damage, 620  
 Radiation effects, 616, 622, 624, 634, 640, 641, 644, 670, 673, 682  
 Radiation hazards, 627, 644, 667  
 Radiation injuries, 666  
 Radiation measurement systems, 613, 626  
     components, 649, 654, 664, 674  
 Radiation protection, 647, 674  
 Radiation tolerance, 616, 625, 628, 630, 636  
     physiological factors, 606  
 Radioactivation analysis, 638  
 Radioactive fallout, 631, 639, 645, 656, 680  
     simulation, 609  
 Radioactive isotopes, 633  
 Radioactivity, 626  
 Radiological contamination, 631, 645, 677, 680  
     simulation, 609

Radiological dosage, 620, 627, 631,  
 653, 681  
 Ranges (Distance), 643, 658  
 Rats, 625, 646, 651, 661, 666, 673  
 Reactor accidents  
     countermeasures, 568  
 Reactor fuels, 669  
 Reciprocals, 665  
 Refineries, 656  
 Reports (USNRDL-TR) in AEC, NSA  
     (UNCLASSIFIED), and ACR (CLASSIFIED)  
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634	17:23095(1963)				
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\*See Preface for explanation of NSA and ACR.

## Resistors

- applications, 604
- Rhodium isotopes Rh-105, 648
- Rocket motor nozzles
  - nondestructive testing, 602
- Roofs, 672

## S

- Sand, 650
- Scintillation counters
  - performance, 602
- Sea water, 637, 650
- Secretion, 676
- Separation, 648
  - instrumentation, 601
- Shelters, 618, 647, 659
- Shielding, 677, 681
- Ships (nonmilitary), 659
- Silver isotopes Ag-111, 648
- Skin, 616, 619, 625, 628, 636, 661, 668, 683
- Sleep, 624, 670, 682
- Sodium, 650
- Sodium ions
  - biochemical effects, 608
- Soils, 650, 662, 686
- Soil moisture, 662
- Solvent extraction, 648
  - instrumentation, 601
- Spectroscopy, 615
- Spinal cord, 682
- Spleen, 628
- Squalene, 671
- Statistical functions, 675
- Stomach
  - electrical properties, 608, 611
- Sulfobromophthalein sodium (labeled), 603
- Surface area, 626, 631
- Surface burst, 635, 639, 658
- Surface properties, 672
- Survival, 652

## T

- Tanlus (containers), 623
- Teeth, 620, 634
- Temperature, 618
- Temperature sensitive elements, 604
- Terrain, 645
- Test equipment, 629
- Thermal conductivity, 675
- Thermal neutrons, 679
- Thermal radiation, 612, 615, 617, 635, 652, 658, 660
- Thermistors
  - applications, 604
- Thermonuclear explosions, 642
- Thymus, 605, 655, 661
- Thyroid gland, 676
- Thyroxine, 676
- Timing devices, 614
- Tin, 632
- Tissues (Biology), 668
- Tolerances (Physiology), 668
- Tracer studies, 638
- Training, 674
- Transplantation, 619, 625, 628, 630, 636, 661, 668, 683

## U

- Underground explosions, 638
- Underground structures, 647
- Underwater explosions, 612, 613, 614, 623, 626, 643, 653
- Uranium, 633
- Uranium isotopes  $U^{233}$ , 679
- Uranium isotopes  $U^{238}$ , 642
- Urethan, 641

## V

- Vacuum apparatus, 692

W

Warning systems, 568  
Washdown, 672  
Wounds and injuries, 683

X

X radiation, 606, 619, 628, 636,  
640, 641, 644, 661, 668, 683  
X rays, 616, 620, 622, 624, 666  
670, 680

# AUTHOR INDEX

## A

Ainsworth, E. J., 627  
 Alpen, E. L., 616, 627  
 Ashwood-Smith, M. J., 666

## B

Baum, S. J., 616  
 Beckman, H. H., 657  
 Benton, E. V., 610, 657  
 Brauer, R. W., 603, 676  
 Broido, A., 652  
 Brown, G., 672  
 Bunney, L. R., 679, 684  
 Buntzen, R. R., 623  
 Butler, C. P., 635, 663

## C

Castanera, T. J., 620, 634  
 Cillay, C. J., 643  
 Clark, D. E., 639  
 Cobbin, W. C., 639  
 Cole, L. J., 605, 619, 625, 628,  
 630, 636, 640, 641, 644, 655,  
 661, 668, 683  
 Cole, R., 626  
 Cook, C. S., 667  
 Cooper, G. P., 682  
 Covey, P. A., 604, 649  
 Crocker, G. R., 642  
 Cummins, J. T., 608

## D

Davis, A. K., 611  
 Davis, W. E., 630, 661, 668,  
 683

## F

Ferguson, J. M., 600, 645, 650  
 Foley, W. A., 641  
 Foti, S. C., 648  
 Frank, A. L., 681  
 Freiling, E. C., 631, 680  
 Freund, D., 659

## G

Gibbons, M. G., 568  
 Goldstein, N., 621  
 Goya, H., 637  
 Greendale, A. E., 601, 607, 632  
 Grisham, J. W., 606, 651  
 Gurney, W. J., 613

## H

Hardy, R. J., 675  
 Hastings, M. B., 681  
 Hege, J. S., 612  
 Heiskell, R. H., 618, 672  
 Heroux, O., 676  
 Huebner, P. E., 674  
 Huebsch, I. O., 653  
 Hunt, E. L., 622, 624, 670

## J

Jenkins, R. J., 663  
 Jones, D. C., 620, 634, 646, 673  
 Joseph, W. F., 626, 664  
 Julian, L. M., 603

## K

Kehrer, W. S., 609, 672  
 Kendall, K., 627  
 Killeen, P. A., 633  
 Kimeldorf, D. J., 620, 622, 624,  
     634, 646, 670, 673, 682  
 Kirby, F. J., 674  
 Krebs, J. S., 603

## L

Lai, M., 637  
 Lane, W. B., 638  
 LaRiviere, P. D., 647  
 Laumets, E., 662  
 Leahy, E. J., 674  
 Lee, H., 647  
 Leong, G. F., 606, 627, 666  
 Lincoln, K. A., 617  
 Love, D. L., 601, 607, 632

## M

Mackin, J. L., 637, 669  
 Main, R. K., 640, 655  
 Martin, S., 652, 660  
 Miller, W. G., 677  
 Minvielle, L., 656

## N

Nowell, P. C., 644, 683  
 Nuckolls, M. J., 638

## O

Olson, M. A., 626

## P

Parker, W. J., 615, 663  
 Pestaner, J. F., 671, 692  
 Plummer, G. E., 677  
 Pond, J. I., 647  
 Pribnow, J. F., 629

## R

Railey, R. M., 638  
 Rainey, S. C., 631  
 Read, P. A., 686  
 Rinnert, H. R., 654

## S

Sartor, J. D., 647  
 Scadden, E. M., 679, 684  
 Schieve, W. C., 675  
 Schleiger, E. R., 621  
 Schultze, D. P., 643  
 Scofield, N. E., 665  
 Shelberg, W. E., 692  
 Shnider, R. W., 658  
 Silverman, M. S., 629  
 Sinclair, K. F., 602  
 Skidmore, W. D., 655  
 Smith, J. C., 622  
 Soule, R. R., 614  
 Strom, P. O., 633

## T

Tochilin, E., 621  
 Tomnovec, F. M., 650  
 Tomoeda, S., 681  
 Tyan, M. L., 605, 619, 625,  
     628, 630, 636, 661

V

Van Horn, W. H., 656, 659  
Vaughan, B. E., 608, 611  
Vella, N. J., 672

W

Walwick, E. R., 640  
Weaver, L. E., 633  
Wesley, E. J., 626  
Wisecup, W. G., 606  
Wish, L., 648

Y

Yahiku, R. Y., 671, 692

Z

Zagorites, H. A., 602  
Zigman, P., 637, 669



DIVISION-AUTHOR INDEX

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A

Ainsworth, E. J., 627  
Alpen, E. L., 616, 627  
Ashwood-Smith, M. J., 666

B

Baum, S. J., 616  
Brauer, R. W., 603, 676

C

Castanera, T. J., 620, 634  
Cole, L. J., 605, 619, 625, 628,  
630, 636, 640, 641, 644, 655,  
661, 668, 683  
Cooper, G. P., 682  
Cummins, J. T., 608

D

Davis, A. K., 611  
Davis, W. E., 630, 661, 668, 683

F

Foley, W. A., 641

G

Grisham, J. W., 606, 651

H

Heroux, O., 676  
Hunt, E. L., 622, 624, 670

J

Jones, D. C., 620, 634, 646,  
673

K

Kendall, K., 627  
Kimeldorf, D. J., 620, 622,  
624, 634, 646, 670, 673,  
682  
Krebs, J. S., 603

L

Leong, G. F., 606, 627, 666

M

Main, R. K., 640, 655

P

Pribnow, J. F., 629

S

Silverman, M. S., 629  
Skidmore, W. D., 655  
Smith, J. C., 622

T

Tyan, M. L., 605, 619, 625, 628,  
630, 636, 661

V

Vaughan, B. E., 608, 611

W

Walwick, E. R., 640  
Wisecup, W. G., 606

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Brown, G., 672  
Bunney, L. R., 679, 684  
Buntzen, R. R., 623

C

Clark, D. E., 639  
Cobbin, W. C., 639  
Covey, P. A., 604, 649  
Crocker, G. R., 642

F

Foti, S. C., 648  
Freiling, E. C., 631, 680

G

Goya, H., 637  
Greendale, A. E., 601, 607,  
632  
Gurney, W. J., 613

H

Hege, J. S., 612  
Heiskell, R. H., 618, 672

K

Kehrer, W. S., 609, 672  
Killeen, P. A., 633

L

Lai, M., 637  
Lane, W. B., 638  
LaRiviere, P. D., 647  
Lee, H., 647  
Love, D. L., 601, 607, 632

M

Mackin, J. L., 637, 669

N

Nuckolls, M. J., 638

P

Pestaner, J. F., 671, 692

R

Railey, R. M., 638  
Rinnert, H. R., 654

S

Sartor, J. D., 647  
Scadden, E. M., 679, 684  
Shelberg, W. E., 692  
Soule', R. R., 614  
Strom, P. O., 633

V

Vella, N. J., 672

W

Weaver, L. E., 633  
Wish, L., 648

Y

Yahiku, R. Y., 671, 692

Z

Zigman, P., 637, 669

ENGINEERING DIVISION

K

Kirby, F. J., 674

P

Pond, J. I., 647

MILITARY EVALUATIONS DIVISION

C

Cillay, C. J., 643  
Cole, R., 626

F

Freund, D., 659

G

Gibbons, M. G., 568

H

Huebsch, I. O., 653

L

Laumets, E., 662  
Leahy, E. J. 674

M

Minvielle, L., 656

O

Olson, A., 626

R

Rainey, S. C., 654

S

Schultze, D. P., 643  
Shnider, R. W., 658

V

Van Horn, W. H., 656, 659

NUCLEAR DIVISION

N

Nanton, E. V., 610, 637  
Butler, C. P., 635, 663

F

Ferguson, J. M., 600, 645, 650  
Frank, A. L., 681

G

Goldstein, N., 621

H

Hardy, R. J., 675  
Hastings, M. B., 681

J

Jenkins, R. J., 663  
Joseph, W. F., 626, 664

L

Lincoln, K. A., 617

M

Martin, S., 652, 660  
Miller, W. G., 677

Parker, W. J., 615, 661  
Plummer, G. E., 677

R

Read, P. A., 686

S

Schleue, W. C., 675  
Schleiger, E. R., 621  
Schofield, N. E., 665  
Sinclair, K. F., 602

T

Tochilin, E., 621  
Tomnovec, F. M., 650  
Tomoeda, S., 681

W

Wesley, E. J., 626

2

Zagorites, H. A., 602

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C

Cook, C. S., 667

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